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CONSERVATION OF SOIL MOISTURE.

With the drought conditions that prevail in many parts of the Colony at the present time, thoughts naturally turn to the question of conservation of soil moisture, and attention can conveniently be drawn to the principles that underlie the system of so-called dry-farming.

It is well known to every gardener that when the weather is dry he should pay close attention to keeping the surface of his soils in good tilth and apply mulch to and around his plants. These two practices tend to prevent evaporation of moisture from the soil and thereby conserve the same for the plants' growth.

In most countries it is now recognised that when the weather is dry, surface cultivations should be frequent in order to form a fine dust-mulch. This is the practice not only for dry districts. It has been demonstrated to be the correct procedure in many tropical countries, and coconut planters in Ceylon have realised the benefits that are derived from these frequent light disc-harrowings during periods of drought.

In arid countries, marked attention has been given to dry-farming during the past few years. The practices that underlie this system of Agriculture are firstly: a deep cultivation to encourage deep rooting of plants and to allow of whatever rain falls to penetrate the soil readily; secondly the maintenance of the humus content of the soil; and lastly the maintenance of a satisfactory dust-mulch by constant surface cultivation.

The extremely dry conditions which prevail where dry-farming is regularly practised do not exist in the cultivated areas of Ceylon, but it has repeatedly been pointed out that the system of dry-farming can advantageously be employed in those areas of the Colony where droughts are not infrequent.

Thorough deep cultivation is occasionally necessary, the conservation of the humus content of the soil essential, and frequent surface cultivations when the weather conditions are dry beneficial. No hard-and-fast rules can be laid down, as much depends upon the nature of the soil and the climatic conditions prevailing.

Discussions have taken place during the year on this question of cultivation of coconuts in the drier districts of the Colony. They have been held at meetings of the Low-Country Products' Association and at meetings of the Committee of Agricultural Experiments.

Coconut planters in dry districts should carry out experiments for themselves. Some of the experiments on the various Trial Grounds indicate most beneficial results where cultivation is regularly carried out, and similarly many estates have been able to maintain good yields by careful attention to cultivation, during the war, when manures were difficult to secure.

There is little doubt that cultivation of coconuts pays, and in other Colonies motor tractors are already being employed upon coconut estates. It is possible that similar experiments may shortly be made in this Colony, and if these experiments are successful, it is probable that even greater attention will be given to cultivation on coconut estates, particularly in those dry areas where conservation of moisture is essential.

The value of mulching should also not be overlooked and those cacao areas in the Colony, which are situated in districts that suffer frequently from long spells of dry weather, should pay particular attention to this form of moisture conservation.

FOODSTUFFS.

CAPSICUMS OR CHILLIES.

H. L. VAN BUUREN.

The genus Capsicum belongs to the Natural Order of Solanaceæ which comprises such important economic plants as the tobacco, potato, brinjal and tomato.

The concensus of opinion favour an American origin of the plants belonging to this genus. WATT, summarising the historical evidence, concludes that the Capsicums must have been introduced by the Portuguese into India and Asia about the middle of the 17th century.

The *Index Kewensis* recognises 54 species as belonging to this genus. Most of these species are attributed to Southern Asia.

IRISH, who continued the investigations of STURTEVANT and monographed the genus (cf. MISSOURI GARDEN REPORT, 1898 p. 53) reduces the number of the species to two, and the so-called species of Asiatic origin are ranked as varieties. This investigator would make out that the two American species introduced into Asia were rapidly disseminated and perhaps through hybridisation have given rise to an infinite variety of forms that botanists have listed and described as species of apparently Asiatic origin.

The two species recognised by IRISH are well-known in Ceylon, and have been listed as two good species. They are *Capsicum annuum* Linn.=*C. grossum* Wild the "Red Pepper" or as we popularly know it as "chilli" or "miris" in Sinhalese. This plant in one or more of its numerous varieties, we grow as our common field crop.

BIRD PEPPER.

The next species is *Capsicum frutescens* Linn.=*C. fastigiatum* Bl.=*C. minimum* Miller.

We have hitherto listed this as *C. minimum* Roxb. It is the "bird pepper" known to the Sinhalese as "nayi-miris," "kochi-miris," or "heen-miris" or "gas-miris."

This species is believed to be the basis of the Cayenne pepper of commerce, but the writer is inclined to doubt the statement. The whole subject needs re-investigation in the light of IRISH's studies of the species and varieties of the genus.

Most writers on Tropical Agriculture have apparently confused this species with varieties of the former. Thus RIDLEY in his "Spices" states "this plant is extensively cultivated in the East Indies, Zanzibar, Japan and elsewhere, and according to ROXBURGH, SIR JOHN KIRK, and most writers, is the source of most of the Cayenne pepper of commerce." WILCOX in his "Tropical Agriculture," quotes nearly the same thing. ALEXANDER, writing on "Spice, Condiment, and Perfume-Producing Plants" (JOURN. ROY. HORT.

SOCY., March, 1910, p. 372) typically represents the confusion existing in economic botanical literature on these species and varieties. Thus "*C. minimum* (the birds-eye chilli) is extensively cultivated.....and turned to use in everyday meals.

"*C. frutescens* is the long, tapering capsicum, possibly more commonly cultivated in European gardens than the other species. It is extensively cultivated in Eastern Asia, and is a product successfully handled by the natives. It is converted into Cayenne pepper."

On the other hand, WATT correctly puts it that *C. frutescens* L. is "hardly a regular crop." Nowhere in Ceylon is this species cultivated as a crop. It may often be found to occur in villages, temple precincts, in waste and rocky soils, perhaps distributed by birds and occurring as weeds or in some cases probably planted. Neither in Ceylon nor in India can this species be said to be "extensively cultivated."

POINTS OF DIFFERENCE.

Another point on which there is confusion is on the size of the plants of the two species. To quote only RIDLEY as typical of this:—

"*C. minimum* Roxb.....A small much-branched shrub, 2 or 3 feet tall, etc.

"*C. annuum* L, is a larger plant with larger leaves, etc."

IRISH's descriptions are as follows :—

"*C. annuum* L. Herbaceous or suffrutescent plants usually growing two or three feet high, sometimes four or five, rarely only a foot"...They are 'annual or biennial.'

"*C. frutescens* L. "Plants shrubby, perennial, 2½ to 6 ft high."

This agrees very closely with the two species as known in Ceylon. *C. annuum* is usually one or two feet high, rarely three feet. It is annual or biennial. The writer has never seen any variety as high as three feet or higher, *C. frutescens* on the other hand is always above three feet except in depauperate specimens and is a shrubby perennial.

Another very good point of difference is in the size of the fruit. In *C. frutescens* the fruit is usually ½ in. to ¾ in long. Fruits longer than this if present must be very rare. The writer has not seen any. Moreover the peduncles are straight and the fruit erect. *C. annuum* has fruits always longer than one inch and typically 2 ins. to 3 ins. long. The peduncles are typically curved or recurved and the fruit pendent, but straight peduncles and erect fruits are known to occur.

C. frutescens is never "turned to use in everyday meals" as often as *C. annuum*. The fruit is popularly used fresh or pickled in vinegar or salt-water. It is noted for its extreme pungency. A sauce or chutney prepared with this fruit is the most pungent *hors-d'œuvre* yet devised. Its fruit is believed to be more popular than that of the other species in native medicine. As *Capsici fructus* it is official in Great Britain.

CURRY CHILLI AND ITS VARIETIES.

C. annuum is used in everyday meals and is an indispensable ingredient in a curry. The dried fruit is ground into a paste for the day's use and mixed with other condiments similarly treated. It is this that is largely imported into Ceylon annually and is capable of more extensive cultivation.

There are a considerable number of varieties. IRISH distinguishes six well-defined varieties consisting of a large number of well-known garden varieties or forms sold by seedsmen. Most of these are fancy kinds. For practical purposes the varieties may be divided into two classes :

1. The pungent varieties used for curry powders.
2. The less pungent varieties used as a vegetable or salad.

These two classes are well recognised in Ceylon, the former being known as "chilli" or "miris" in Sinhalese ("Kochika" or "Molaghai" in Tamil) ; the latter class now popularly called "capsicum" or "Bell Pepper" and "malu-miris" in Sinhalese ("Kari Kochika" or "Kari Molaghai" in Tamil).

The curry chillies can be divided into two or perhaps three groups.

(a) Forms with a thick skin less pungent and approaching the bell peppers.

(b) Forms with a thin skin, very pungent, the fruit generally long and tapering or as in (c) the cherry peppers, the fruits being generally globular or spherical and in some forms heart-shaped. This latter is what IRISH describes as *C. annuum cerasiforme* (Miller). The flesh of the fruit is more often firm and thick, but extremely pungent. A good demand may arise for these fruits because of their pungency, but at present these forms are not so well-known in Ceylon,

THE VARIETY TO PLANT.

Of forms (a) and (b) the latter with a thin skin and greater pungency should always be preferred for planting as buyers can discriminate very well between the two forms, every housewife knowing that of forms (a) more chillies are required to give the necessary zest or relish to a curry. IRISH describes forms of this variety (b) which is to us the most important as *C annuum acuminatum* Fingerh. Plants are described as $1\frac{1}{2}$ to $2\frac{1}{2}$ ft, high ; the fruit very slender, $\frac{1}{2}$ to $4\frac{1}{2}$ in. long, $\frac{1}{4}$ to $\frac{3}{8}$ in., diameter, smooth or sub-rugose, usually more or less curved, 2-celled, flesh very thin, about 1/24 in. thick, extremely pungent, red or yellow.

This variety is popularly called "finger-pepper" and is well-known as the dried imported chilli in Ceylon. The best known forms sold by seedsmen are "Long Cayenne" and "Nepal Chilli." This is the most extensively cultivated variety in India and should be grown more extensively in Ceylon.

THE VARIETY NOT TO PLANT.

The forms which should not be cultivated as being less pungent are described by IRISH as *C. annuum longum* Sendt. "The varieties differ from *C. annuum acuminatum* by the stems and branches being larger and more stalky ; leaves larger, often pendent and involute, calyx pateriform or funnel form, fruit larger and flesh thicker." The flesh is recorded as "1/12 to 1/6 in. thick, sometimes mild, sometimes extremely pungent." Of one form sold by seedsmen, i.e., "Country Fair," IRISH states : "This is one of the most productive of the long varieties, as well as the best in quality [perhaps for the European or American markets.—H. L. VAN B.] and merits a high place where pungent properties are not desired."

The other varieties need not be considered, as they are of interest only to the fancy grower.

THE VEGETABLE CAPSICUMS.

The edible capsicums or bell peppers may now be considered. These are referred by IRISH to *C. annuum grossum* Sendt. "Plants herbaceous 1½ to 2 ft. high.....Fruit large, oblate, oblong or truncated deeply 3 to 4-lobed usually with a basal depression, more or less sulcate and rugose, 3 to 4-celled, flesh 1/12 to 1/8 in. thick, firm and of mild flavour."

Of the forms sold by the seedsmen are:—

Monstrous. "A late but prolific variety, originated in France."

Sweet Spanish. "A form of *Monstrous.*"

Bell. "The fruit appears exceptionally subject to great variation, and very oblate forms often appear which are almost identical with the squash pepper."

Sweet Mountain. "Considered a synonym of Bell, but the uniformly smaller plants and larger and milder fruits, which are not subject to great variation, make it quite distinct, though at most it is but a sub-variety or improved form."

"Bell" and "Sweet Mountain" are forms introduced and tried in Ceylon with success.

Squash. This is a very late variety and not an abundant bearer. Flesh rather insipid often with a trace of tomato flavour.

These capsicums are eaten raw or cooked or employed in pickles. They may be sliced and mixed with salads or served like tomato with vinegar and salt. When curried and eaten as a vegetable, the fruit is cut down one side, the seeds removed and stuffed (in Ceylon) with the dry powdered Maldive fish.

CULTIVATION.

With reference to the growing of chillies, most are agreed that it is one of the easiest crops to grow. In the "TROPICAL AGRICULTURIST" for November, 1908, a tea planter of Natal, MR. W. A. GILBERT, showed how he made good profits by growing chillies as a catch-crop with young tea. He planted chillies in the same rows with the tea between the tea plants and put 2 plants in each hole. The chilli plants were picked off from a nursery when they were 10 to 12 ins. high and the roots and tops of each plant trimmed off before transplanting. The plants struck root in 2 weeks and ripened fruit in 5 to 6 months. Such a method is worth noting on new clearings where the virgin soil is sure to give very heavy yields.

The chillies may be grown in two ways. First, as an annual, replanting every year. Second, as a perennial, when the plants should be cut back to 9 ins. each year. In this way chillies may bear for 5 to 6 years, but it is advisable after the 2nd year to replant, as the fruits deteriorate in size and pungency.

In Singapore, the Chinese prepare the seeds in a peculiar way for sowing. Seeds are taken from fresh pods and soaked in salt fish water for seven days. They are then taken out and dried well and mixed with soft earth. This operation rids them of the gummy pulp which causes the seed to stick together and prevents unevenness in sowing.

With regard to climatic and soil conditions, chillies are subject to rot when much rain is experienced particularly during the fruiting time. This is due to a fungus and the damage is often very serious. The damaged fruit should be gathered and burnt and the plants and if possible the soil sprayed with Bordeaux mixture.

Chillies do best on sandy loam or alluvial soils. In hilly districts it is believed that the fruit grown are more pungent. Lime in the soil is very favourable to the plants and they come up well if rotated with legumes. On sticky soils it will be necessary to manure well with organic manures to be successful in their cultivation. In such soils it will be necessary to have the soil of the seed-bed mixed well with river sand if the seedlings are to come up well. Watering is necessary during dry weather and with liquid manure good crops can be realised. The outturn of dry chillies varies from 750 to 1,000 lb. per acre with the dry crop, to 1,200 to 2,000 lb. with an irrigated crop. Dry chillies are quarter their green weight.

CAYENNE PEPPER.

As of little more than passing interest, the Cayenne pepper of commerce may be noted. This consists mainly of the fruit of the small pungent varieties reduced to a fine powder and mixed with almost 15 times as much flour made into cakes and baked. When quite hard and brittle after baking, these are reduced to powder and sifted. The powder is bottled and sold as Cayenne pepper.

The Mombassa chilli, a fruit about ½ in. long, is considered the strongest grinding chilli. The Japan chilli about ¾ in. is not so pungent. There is no information available as to whether these are *C. annuum* or *C. frutescens*. Most writers place it under the latter or one of its synonyms. IRISH puts the forms "Tabasco" and "Cayenne" (listed as *Cayenne* of Commerce in contrast with *Long Cayenne*) as belonging to *C. annuum conoides* (Miller). This is distinguished from *C. frutescens* in that the plants are not perennial and usually not over 1½ ft. high, whilst the fruit ripen earlier than *C. frutescens* which matures slowly and rarely ripens fruit except in the extreme South of the United States. It is for this reason that the source of Cayenne pepper needs determination after a careful study of the plant.

HOW TO PREPARE MAIZE FOR BREAD OR PUDDING.

Amongst suggestions for the preparation of locally-grown foodstuffs, in a circular issued by the Acting Director of Agriculture, Trinidad, the following is worth drawing attention to: "To prepare Indian corn to get best results for several kinds of bread or pudding, it is best to take off the skin. This is done as follows: To 2 lb. corn allow 2 lb. sifted ashes and about 1 gallon water, and boil for one hour. It is sufficiently boiled when a grain squeezed between the fingers pulps out of the skin. Place the pot from the fire under a stream of cold water, and rub the corn with the hands, when the skin will easily separate, and the overflow of water will carry away all the ashes and the skin. When clean, drain off the water, add about 1½ gallon clean water, and re-boil for about fifteen minutes. The grains must then be crushed into a fine paste, either in a mill or a meat mincer"—AGRIC. NEWS, Nov. 8, 1918.

THE JAK *(ARTOCARPUS INTEGRIFOLIA)* AS A FOOD CROP.

W. MOLEGODE.

Is the best use made of the Jak as a food in the Island? Jak is found everywhere in abundance and in the season there occurs a great wastage of the fruit which can be conserved for future use. The tree under favourable conditions is a heavy bearer and sometimes the fruits are of a tremendous size and weight. Fruits weighing 50 to 60 lb. containing 10 to 15 lb. of edible matter each are common. I once exhibited at the Nuwara Eliya Show a fruit weighing 108 lb. In the villages often a single fruit serves as a full meal to a family of 3 or 4 members. Jak is considered to be a wholesome and nutritious food and apparently there is truth in the village saying: "that both men and cattle get fatter during the jak season." In its ripe state it is a favourite fruit. The unripe fruit is one of the chief vegetable diets of the population. It even frequently takes the place of rice and used as a full meal in the poorer homes. From the early stage of the fruit till it is fully ripe, the different stages are known up-country as *polos*, *ketikos*, *dandukos*, *pehechchakos*, and *vela* or *waraka*; it is used in a variety of ways. The ripe fruit can only be appreciated if eaten at the right degree of ripeness. Over-ripe fruits not only give a disagreeable smell, but soon lose the flavour. There are two forms of the ripe jak—the *vela* and *waraka*; the former gives a very soft pulp and is less appreciated than the latter, the pulp of which is firm and not soft nor hard. From the stage of *polos* till it is nearly ripe, the fruit is capable of being used as a vegetable.

In the up-country during the season which extends from March to June, thousands of fruit are allowed to waste; and it is possible, if the people care to, to preserve a great deal of this for future use. Anticipating a shortage of food in the villages last year, I had mentioned to my home people the possibility of, in some way, meeting the constant demand of the poor if much of the jak and breadfruit were preserved, and I am happy to be able to say that in this way, we may have appeased the hunger of several starving women and children.

The pulp of the mature, not ripe, fruits and the seed of both are prepared for food in many ways. The seed contains a large percentage of starch, and as such can be utilised in several ways. Roasted, it is nice and palatable and is likened to the chestnut. Boiled, dried and grounded, it can be made into flour. It is easily preserved and the method of doing this is simple: Seeds of the ripe fruits are collected and dried in the sun to remove the moist condition of the cover. They are then mixed in soft sand and stored in a dry place. In this condition, the seeds can be kept for 6 to 10 months. To preserve the pulp, a little more attention is necessary. The pulp has to be boiled a little—not too much—and dried over the fire or in strong sunlight till they are brittle and are packed in chatties or boxes and kept in a dry place. The ripe pulp of the *waraka* can also be preserved in syrup.

Almost at the outbreak of the war, an attempt to induce people to grow more jak was made. The Agricultural Society supplied some 30,000 seeds. If the people planted jak then, by now those trees would be giving a crop, as Jak comes into bearing in four years under good conditions.

THE JERUSALEM ARTICHOKE: A NEGLECTED SOURCE OF FOOD.

Under the above title, Professor T. D. A. COCKERELL, of the University of Colorado, contributed an article to the SCIENTIFIC MONTHLY of March, 1918, to which we are indebted for much of the following.

The sun-flowers, genus Helianthus, are native only to the Western Hemisphere. About seventy valid species are recognised by botanists as occurring in America, North of Mexico, and between twenty and thirty species are found South of that line as far as Peru.

The species of Helianthus in the North-Eastern United States and the adjacent parts of Canada develop edible tubers, so that there is a group of sun-flowers, which possess no permanent aerial stems, but are reproduced annually both by seeds and by underground stems. Plants like these are ordinarily classed as perennials ; they are, however, only perennial in the same sense as the potato is. Among these perennial sun-flowers is the Jerusalem artichoke (*Helianthus tuberosus*).

As in the case of the potato, the tubers of the Jerusalem artichoke arise from underground stems. The tubers of the potato are terminal, that is to say, produced at the extremity of the underground stem, whereas those of the Jerusalem artichoke are formed laterally also, or the underground stem itself may swell up and become a tuber. Consequently the Jerusalem artichoke bears a mass of tubers close to the main stem, although others may be more widely separated in the soil. Accordingly the tubers are very easy to harvest, and the space occupied by them is surprisingly small considering their quantity.

Helianthus tuberosus is not the only member of the genus which has been used as a source of edible tubers. *H. sub-tuberosus*, the so-called Indian potato of Michigan, has thick, fleshy, edible tubers. *H. doronicoides*, a native of Ohio, is used as food in Europe in the same manner as salsify.

As a source of food, *Helianthus tuberosus* was well known to the natives of America long before the advent of the white man. The tubers were much valued by the Indians on account of their hardiness and productiveness, and because they retained possession of the soil for many years. These tubers were mentioned by the French Explorer, CHAMPLAIN in 1603, and brought to France by LESCARBOT in 1612, who described them as being as big as small turnips, excellent to eat, with the taste of artichoke, but more agreeable, and multiplying in a wonderful way. Strange to say, though originally so much valued in the New World, the plant is now much more cultivated in the Old World.

The tubers appear to have been highly appreciated in Europe from the first. The plant was grown in the Farnese Gardens at Rome, and was distributed thence under the name of Girasole Articiocco, or sun-flower artichoke. PARKINSON, the English botanist, noted in 1629 that they were then very commonly offered for sale in London.

The name artichoke is supposed to be derived from the Arabic name applied to a thistle-like plant, *Cynara Scolymus*, a native of the Old World. This is the true artichoke, and the edible part of that plant is the flower head, particularly the thickened involucral bracts. This and the Jerusalem

artichoke have little in common, the plants being entirely different in appearance, and furnishing quite different parts as food. The name artichoke appears to have been given to *Helianthus tuberosus* solely on account of its somewhat similar flavour, while "Jerusalem" is only an English corruption of the Italian "Girasole," which means sun-flower. Thus the designation "Jerusalem artichoke" is as misleading as "Guinea pig." The French have a distinctive name, "Topinambour," and the name in Spanish is "Cotufa." In view of the astonishing size of the crop and the value of the tubers as human food, it is singular that this plant is so largely neglected at present in the Western World.

An experiment conducted by Professor COCKERELL himself in Colorado, gave a yield of 9·66 tons to the acre, and this has been exceeded in several other localities of the United States. In England, Messrs. SUTTON & SONS have reported a yield of 18 stone of splendid tubers from 6 lb. planted. It must be remembered that the average yield of potatos in the United States is said to be 84·5 bushels, though rising in some States to an average of over 150 bushels. Against this, the ENCYCLOPÆDIA AMERICANA states that the usual yield of Jerusalem artichokes is 200 to 500 bushels per acre, and that 1,000 bushels are sometimes obtained. The Jerusalem artichoke requires less labour to plant and to cultivate than the potato.

As a tuber for general cultivation, the Jerusalem artichoke is not likely to become a successful competitor of the sweet potato and other edible tubers cultivated in the Tropics, although it can be grown and gives very large returns in these regions. It is, for instance, successfully grown in the Philippine Islands and in some of the West Indies.

Under the cultivation in Europe, especially in the hands of VILMORIN in France, and SUTTON in England, several improved varieties have been put on the market, and doubtless such breeders in the future will still more improve the plants, and produce sorts adapted to special purposes and conditions.

The food value is about the same as that of the potato. As a food for stock, particularly hogs, it is stated that the Jerusalem artichoke is about equal to potatos, and richer in protein than sweet potatos. The dried leaves and stalks of the plant have been fed to sheep and cows, and found about equal in nutritive value to good meadow hay. The young plants are also sometimes used as forage for cattle.

As a human food, the tubers can be used boiled as a vegetable or as a salad, or in soup. In preparing them for the table, the irregularity of the tubers makes them hard to peel, and their peculiar taste is sometimes objected to at first, although it is easy to acquire a liking for them.

The cultivation of this plant, which is equally valuable as food for man and beast, might add very considerably to the food resources of these islands. The greatest obstacles seem to be prejudice and want of knowledge.

In Cuba, some interest is being taken in the cultivation of this plant. An article in the official organ of the Department of Agriculture, Cuba, July, 1918, from the pen of DR. MARIO CALVINO, draws the attention of Cuban planters to the desirable qualities of the Jerusalem artichoke. The Doctor considers that the best way to grow this crop is to select healthy and vigorous small tubers, and to plant them in furrows, about 3 feet apart, the tubers being placed about 2 feet one from the other.—AGRIC. NEWS, Nov. 16, 1918.

THE CULTIVATION OF ONIONS IN LAKSHMISAGARA, MYSORE DISTRICT.

C. NARASINGA RAJU, L. Ag.

(*Agricultural Instructor, Mysore*).

Lakshmisagara is a village about six miles from French Rocks town, situated at the foot of a small range of hillocks. The source of water supply for irrigation of this village is from the Thonnur tank which is about 4 miles off this place and the supply is perennial. Onion and paddy on wet lands and Ragi on dry lands are the crops chiefly grown. Onion is grown on a large scale rotated with paddy, and being a money crop, more care is bestowed upon it, and is a specialty of this village. It is cultivated mostly on wet lands under tank irrigation. As a market-garden crop, a few ryots grow it on a small area under well irrigation. Under ordinary conditions, a yield of about 320 maunds of onions per acre is obtained, worth about Rs. 240 to Rs. 300 depending on the market rate. Mysore, Bangalore, Chennapatna, Tumkur and Chenrayapatna are the chief markets for this onion.

SOIL AND SEASON.

The soil is of black sandy loam and red sandy loam friable and well-drained.

There are two seasons for planting. The first one is in the early part of January in the Purvashada rain ; the second is in the Mungar rain of Rohini, i.e., in the beginning of June. The season of planting affects the duration and yield of crop. The first crop takes full three months to mature, and gives slightly less yield than the Mungar crop, which occupies the ground only for a period of two-and-a-half months.

VARIETY.

There is only one variety cultivated, called Raja Irulli which is of reddish colour, and the diameter of an average bulb is $1\frac{1}{4}$ in. in the widest part.

SEED-BED AND SOWING.

Seed bulbs are raised in beds ($4\frac{1}{2}$ in. × $1\frac{3}{4}$ in. each) from seeds, and allowed to rest from 40 to 50 days, after they are removed from the ground, and then planted. Simultaneously with transplanting of the seed bulbs big matured, bulbs are planted in separate beds for seed, and seeds are sown in nursery for raising seed bulbs for the next season.

100 beds ($4\frac{1}{2}$ in. × $1\frac{3}{4}$ in. each) or one *gunta* of land is sufficient to plant matured bulbs to get seed for sowing 100 seed-beds ($4\frac{1}{2}$ in. × $1\frac{3}{4}$ in. each) which give enough seed bulbs for transplanting one acre. The seed-beds are dug with *gudaly* or ploughed three times, during October to December, for the first crop and during April and May for the second crop and exposed to weather. After the land is reduced to fine tilth, it is manured with cattle manure at the rate of 10 cart-loads per acre and ploughed once again. Then the beds are formed and sown with fresh seed, for seed bulbs and in separate beds, matured bulbs are planted for seed. When sowing the seed, it is only just put under the ground, as it requires very slight covering of soil. The matured bulbs are planted about 4 in. apart each way, leaving the "neck" about $\frac{1}{4}$ in. above the surface of the soil. There are few seeds so annoyingly deceptive as onion seed, as old seed will lose its germinating power, and seeds imported unless properly preserved will scarcely germinate at all. Therefore the ryots of this village pay special attention to raise their own seeds. About ten seers of seed is gathered after four months from 100 beds planted with

matured bulbs. The seed is well dried and preserved in earthen-pot covered with straw ashes, and plastered with cow-dung and red earth to make it air-tight. Seed sown in the nursery germinates in about a week, and the seed bulbs are removed when they are about 40 to 50 days old. The tops are wrung out and bulbs are left in a heap covered over with Jola stalks or spread on floor inside the house subject to a free current of air. Should they show signs of heating, they are at once turned over and the bad ones picked out.

PREPARATORY CULTIVATION AND TRANSPLANTING.

The land is ploughed five times with the country plough, and brought to a fine tilth, during the months of October to December or April and May. Then beds ($4\frac{1}{2}$ in. × $1\frac{3}{4}$ in.) are formed with bunds 4 in. wide and 3 in. high. Three men prepare 1,000 beds in a day. 4,000 beds are made in an acre of land. No manure is given until the first hoeing. Planting is done in the afternoon after 2 o'clock, or in the morning on a cloudy day. Before planting, the beds are watered, dug with *gudaly*, levelled and then planted with seed bulbs, 4 in. to 5 in. apart each way. Ten women and seven men in half-a-day plant 1,000 beds.

AFTER-CULTIVATION AND IRRIGATION.

Only one hoeing is given twenty days after planting, when the full dose of manure (10 cart-loads) is applied. One woman for every 150 beds is employed for hoeing and four men per acre for manuring. For the first forty-five days, the beds are hand-watered once in three days from pits (2 in. diameter and $1\frac{1}{2}$ in. depth) dug out in the field at convenient distances according to the area of the field. These pits are filled with tank water from the irrigation channels. After forty-five days the crop is flooded once a week.

HARVESTING.

The crop matures in $2\frac{1}{2}$ to 3 months. One man is employed to dig out 100 beds, wring out the tops and clean. The bulbs are stored in the same way as the seed bulbs if necessary. If stored for three months, about 20 per cent of driage will occur. The yield per acre ranges from 300 to 400 maunds. There are cases where the yield has been over 500 maunds per acre.—JOUR. OF THE MYSORE AGRIC. & EXPERIMENTAL UNION.

GERMINATING SEED PADDY.

MR. W. MOLEGODE has written the following note :—

"In the Kandy District the seed is well winnowed, removed of all dust and empties and put into a tub or chattie (earthen-pot) and sufficient water poured to well saturate the seed. In this state it is kept for a full day and night. The following day the seed is spread over plantain leaves and nicely formed into a bed and covered all round and on the top with the same leaves. Light weights are put on this bed and the seed is allowed to remain in this state for 5 to 7 days calculating 1 day to each month of the 'age' (i.e. Hondarawala 5 days, Hatiel 6 days, Mavi 7 days). A day previous to sowing, the bed is opened and the germinated paddy gently loosened and spread on a freshly 'cow-dunged' floor to further hasten growth before being sown."

To which MR. N. WICKRAMARATNE adds :—

"In the low-country the method is slightly different. The seed is soaked in water after being placed in a bag (either a rush bag or 'gunny') for 24 hours. Plantain or habarala (colocasia) leaves or even mats are used for covering the soaked seed after spreading on the floor. The lumps and seeds are broken up by the two palms of the hands and the separated seedlings sometimes sprinkled with water before sowing. The number of days taken in germinating is, owing to climatic conditions, less than in Kandy District."

FRUIT.

A FEW NOTES ON CITRUS CULTURE.*

ALBERT H. BENSON.

(*Director of Fruit Culture*).

At your last Conference, which was held in October, 1917, a long, interesting and instructive paper on "Citrus Culture" was read by the late MR. S. C. VOLLER, and was evidently much appreciated, as your Secretary has asked me to prepare a paper on the same subject for submission to you to-day.

As I have already dealt very fully with this matter in my writings, I do not consider it necessary to go into details now, but will confine my remarks to those points that are of especial interest to growers at the present time. Should any grower require further information than that contained in these notes, I would refer him to the last Edition of my work on Citrus Culture, issued in 1916, and which can be obtained on application from the Department of Agriculture and Stock.

There are, however, certain well-established facts connected with the industry on which the success or failure of the orchard is very largely dependent, and although these facts are well-known to the majority of growers, they will bear repeating as they are of the greatest importance to beginners.

In the first place, the selections of suitable soil and a suitable situation for the Citrus orchard is imperative, as without these essential factors, the commercial success of the undertaking is very doubtful under existing conditions. Intending growers cannot afford to make any mistakes at the start, but must be certain that the land they select is suitable in every way, which means that, not only must it possess perfect natural drainage, but it must be capable of being worked economically.

This narrows the choice of sites, as the only soils that will fulfil these conditions are deep, free loams or sandy loams that will not retain stagnant water even during periods of heavy and prolonged rainfall, and the choice of such soils is further limited, when cost of working is taken into consideration.

Level or nearly level land is much cheaper to work than hillside land, as practically the whole of the cultivation that is so necessary to keep down weed growth, and to conserve water in the soil during a dry time, can be carried out by horse labour and the use of up-to-date implements of cultivation.

Level land possessing a suitable soil does not wash during periods of heavy rainfall, and thus there is no danger in keeping it in a state of perfect tilth; further, the cost of spraying or cyaniding and the gathering and handling of the fruit is materially reduced, and manures are not washed out.

Other conditions being favourable, it will thus be seen that the more level the land the better, as the cost of producing and handling the fruit is considerably reduced.

* Read at the Fruit Growers' Conference held at Palmwoods, 2nd November, 1918.

Having selected suitable land, the next step is its preparation. This should always be thorough, as once the trees are planted you never get as good a chance again, and, though the initial expense is greater, it always pays in the long run. The same remark applies to the selection of the trees and planting. Only well-grown, perfectly healthy trees should be planted, and they should be planted properly. This necessitates, first, a careful examination of the roots and cutting away all badly-bruised or broken roots, and secondly, the planting of the tree at the right depth and placing the roots so that they will have a downward and not an upward tendency.

To do this, the digging of large or deep holes is not necessary, as, if the land has been properly prepared; all that is required is to make the hole large enough to take the spread of the roots, and for the tree, when planted, to stand in the soil at the same depth it stood when growing in the nursery. The centre of the hole should be a little higher than the sides, so as to give the roots a downward trend.

If dry at the time of planting, place a little fine top soil round the roots when they are placed in position, and then give the tree a good watering and fill in the hole with soil. This will give the tree a start, as the water will not dry out quickly on account of the soil-mulch above the wet ground, whereas if a surface watering is given, the effect is soon lost.

We now come to one of the most important parts, and that is the pruning of the young tree as soon as it is planted. In removing the young tree from the nursery, it has been deprived of most of its root system, especially the fine, feeding roots, so that it is necessary to reduce the top in order to give the root system a chance to recuperate, and it is also necessary to cut back so as to provide a strong framework for the future tree. This means that only a limited number of branches are left, not less than three nor more than five, as these first branches eventually become the main limbs of the tree. Many growers make the mistake of leaving far too many branches, with the result that the branches are too crowded and very weak, so that when they are laden with fruit, they are unable to bear the weight and frequently break down. This is often seen in the case of mandarins, and particularly with the Beauty of Glen Retreat, which requires very careful attention when young, as it is apt to produce a dense growth of weak wood unless its main limbs are properly established and all subsequent growths are kept severely thinned. If the tree is not pruned out properly, it will overbear, the result being a great crop of undersized fruit one year, that is hard to dispose of, and a sickly-looking tree and very little fruit the next.

No citrus tree should be allowed to grow into a dense bush, as it is impossible to spray such properly, and consequently they become a breeding ground for all kinds of pest. A typical citrus tree should have one main trunk from 18 inches to 2 feet high, with not more than three to five main branches, and these main branches should only be allowed to carry sufficient subsidiary branches to form the framework of the tree. All others are unnecessary and should be removed.

The inside of the tree should never be crowded, the limbs should be properly spaced, and the outer branches on which the fruit is produced should not only shade the inside of the tree, but the ground under the tree, so that as long as the lower branches are clear of the ground, when in fruit, they can be left on.

High heading is not, in my opinion, desirable in this climate, as the ground requires shading from the summer heat, and further, the more of the crop that can be gathered from the ground the better.

The great fault of beginners is that they are afraid to prune hard enough, and there is frequently much more harm done to the trees by under-pruning than by over-pruning.

Properly-pruned trees produce regular crops, as they make a good growth annually, but under-pruned trees are very apt to overbear one year and consequently to make little new growth, so that the following year they have a small crop and have to make wood for the next season's crop.

The pruning of the lemon is quite different from that of the orange or mandarin, once the tree is given its permanent shape, as, unless the long-straggling growths, it is prone to throw out, are kept well shortened back, so as to encourage the production of fruit-producing laterals, you get a very untidy tree that bears the majority of its fruit at the ends of long branches that sway about in the wind and rub or bruise much of the fruit. In pruning the lemon the main object is to encourage lateral growths on which to grow the fruit, and to discourage the production of long-straggling branches. A well-pruned lemon tree in full bearing should not be more than ten feet high, and should have its laterals so spaced that there is no overcrowding. Such a tree will bear even crops of well-grown fruit, whereas a tree allowed to run wild, will produce a lot of coarse fruit which is hard to dispose of.

So far I have only dealt with the pruning of young trees and healthy trees, but it frequently happens in old or neglected orchards that quite another class of pruning is necessary—namely, pruning for renovation. This is a very important matter, as, if it is carried out in time, many an apparently worthless tree can be brought round and made to produce profitable crops. The bearing wood of many old trees frequently becomes useless as the result of drought, neglect, starvation, want of pruning, insect or fungus pests, etc. The wood is hide-bound and there is no free flow of sap. Such trees frequently show signs of gum on the main branches and they throw out many water sprouts. Trees showing these symptoms should have their roots carefully examined, and if the roots are found to be healthy, they can be brought round by giving them proper treatment. This consists of removing the top of trees, cutting back all limbs till sound, healthy bark and wood are met with, and removing all dead or superfluous main branches. The tree is then painted or sprayed with a strong solution of lime-sulphur, not less than one part of the standard solution of 32 deg. Beaumé in 10 of the mixture when used as a spray, or even much stronger when used as a paint. The ground round the tree should then be worked up well and a good dressing of a complete fertiliser given. This work should be done when the tree is more or less dormant, and as soon as rain comes young shoots will make their appearance all over the tree, and these should be carefully thinned out, only leaving enough to form the new top of the tree. If these young shoots make a strong growth, they should be checked, so as to encourage lateral growth, and this in turn must be thinned out. If this work is carefully carried out, a tree that was practically useless on account of its worn-out top, will have a new head of vigorous growing wood which will produce good fruit. If the tree is then properly looked after—that is to say, kept pruned, manured, sprayed, and cultivated—it will continue to yield a profitable return for many years.

The next point to be considered is how to keep the orchard clean—that is to say, free from insect and fungus pests. The first consideration is to keep the trees in a healthy and vigorous condition by proper pruning combined with thorough cultivation and systematic manuring, as healthy vigorous trees are able to throw off many pests that a weakly, neglected tree would succumb to. The second consideration is to systematically inspect the whole of the trees in the orchard at regular intervals, so that the presence of any disease can be detected before it has become firmly established, as it can then be stamped out before it has had time to do serious damage.

The trouble is that many orchardists fail to recognise the importance of taking steps to fight diseases as soon as they make their appearance, and frequently allow their trees to become so badly infested that their vitality is seriously injured; the crop suffers in consequence, and the cost of cleansing the orchard and bringing the trees back into a healthy condition is a heavy tax on the grower. Diseases such as borers of all kinds, gumming, both of the branches and around the collar of the tree, bark-destroying fungi of several kinds, and red scale, require attention as soon as ever they make their appearance, and if they are taken in hand promptly, they cause little damage, but if they are neglected the tree soon shows signs of distress.

In fighting fruit pests the old saw: "a stitch in time saves nine" is very sound advice and should be kept in mind by all growers, as by acting up to it, they will be saved a lot of trouble and expense.

I will not go into further details to-day, as I have just revised an Edition of my pamphlet on Fruit Pests, which I have tried to bring up to date, and which is now in the hands of the Government Printer, so that, when issued, I trust, it will be found useful to growers.

I will now conclude my remarks with a little general advice on marketing the fruit, as no matter how well you keep your orchards, and no matter how good fruit you grow, you will not get the best returns unless it is properly marketed.

Now, what I mean by being properly marketed is, that the fruit must be placed on the market in the best possible condition, so that when opened up for sale, it will show off to the best possible advantage.

To do this the grower must spare no trouble—he must gather the fruit carefully so as to prevent bruising, he must grade it, both for size, quality, and colour, and he must only pack one grade of even size, quality and colour in a case, so that when the case is opened up for sale, the fruit will not only show to the best advantage, but the shown surface will indicate the quality of the whole of the contents, and buyers will know exactly what they are purchasing.

Fruit will have to be packed in this manner in order to comply with the Victorian Regulations, and, therefore, it is advisable to pack all fruit properly, so that there will be no difficulty in their being admitted into any State.

In the case of our local Queensland markets, our Regulations demand honest packing and the correct marking of the case, and growers, who fail to comply with the law, are being proceeded against.

The honest packer has nothing to fear, and it is only fair that he should be protected from the man who tops his fruits or puts it on the market under another man's brand.—QUEENSLAND AGRIC. JOURNAL, Dec., 1918.

GRAFTING THE GRAPE-VINE.

H. V. GOLE,

(Grape-Grower, Nasik).

Among other advantages of grafting the grape-vine, it is claimed that the effect of grafting is to produce a constant weakening of the scion with increased fructification, a greater number of closely-set bunches with large berries, more juicy and frequently richer in saccharine matter, and an early ripening. HUSMANN also believes that grafting increases fruitfulness, the temporary obstruction seeming to have the effect upon the graft of making it produce more and finer fruit than on its own roots. He has also recorded similar experience of other eminent growers.

The matter seemed worthy of investigation and led me to undertake a few experiments as already remarked in Bulletin No. 71 (of 1915) of the Bombay Agricultural Department. The principal varieties of grapes grown at Nasik are only four. Bhokari, being a good cropper, is much in favour and largely grown, while Fakari, Sahibi, and Hafsi or Kali, being very shy bearers, are never grown beyond a few vines in a plantation, though these varieties are decidedly superior. If grafting produced increased fruitfulness, the problem here was to ascertain whether some of our shy bearers could be made to yield more and better fruit by grafting them on other stock.

I had no clear notions about the influence of the stock upon the scion. I vaguely imagined that Bhokari, being very prolific, might exert a favourable influence upon the scion. Also, as Fakari, Sahibi, and Kali are very vigorous growers, producing abundant foliage—perhaps at the expense of fruit—I should be able to check this habit of vigorous growth by selecting a stock which was a moderate grower by habit, such as Bhokari. On these considerations, I decided to use Bhokari as stock.

The next point was to select the method of grafting. Various methods of grafting and budding have been suggested. As I had very little experience in grafting, I chose to operate in four different manners, namely :—

(1) Grafted cuttings,
(2) Grafting by approach,
(3) Crown grafting, and
(4) Side-cleft grafting.

GRAFTED CUTTINGS.

For successful grafting it has been found that the temperature should not exceed 20° or 25°C. As cuttings could only be obtained in the beginning of October, I tried grafted cuttings at this time, though the temperature conditions were not favourable. All the trials failed successively for three years (1914 to 1916). In preparing the graft, the cut has to be made one-half to one inch above and below a node upon the stock and scion respectively. This left the knitting surface much too small. The grafted cuttings should have been kept for callusing in fresh moist sand before they were set to root. I admit that I had not followed this instruction. Be it from whatsoever cause, none of the grafted cuttings rooted, and I gave up the trials after three years.

GRAFTING BY APPROACH.

In 1913 a *mali* from the Ganeshkhind Botanical Gardens, Kirkee, grafted on two Bhokari vines in one of my plantations, operating by the usual method of grafting by approach (tongue graft). Both the grafts knitted well and were successful. Fakari canes were used for scions. Both grafts were pruned in April, 1914, to form the head. One of the grafts was accidentally destroyed while ploughing. The other graft was again pruned for fruit in October, 1914. The stock of this graft is 40 in. long and the scion after heading in was 24 in. long. It gave six bunches of good size, while there were only four small bunches on the parent vine, that is, from which the scion was taken. The result was tolerably fair and encouraging. This graft is bearing splendidly every year.

I have found that grafting by approach is a much surer method—the grafts knit well and the chances of failure are few. I have other grafts prepared by the approach method. One is bearing fruit beautifully. The length of the stock is 24 in. and that of the scion after heading is 40 in. Three other grafts had to be transplanted elsewhere in April, 1917, as they happened to be in an isolated condition, but they have not as yet recovered from the shock.

But there is one disadvantage with this method. As the number of vines for the scion is only limited in a given plantation, only a few vines can be grafted by this method. I thought of trying a method which shall be quite independent of the position of scion vines, which is described below.

CROWN GRAFTING AND SIDE-CLEFT GRAFTING.

In October, 1914, I tried 10 crown grafts and 10 side-cleft grafts. Four crown grafts were put below the ground and the rest above the ground. Only one graft above ground knitted well and was successful. Again, in the following year, out of nine crown grafts and nine side-cleft grafts, only one crown graft above ground was successful. The trials in 1916 and 1917 failed to give even a single successful graft. From this it appears that crown and side-cleft grafting are much more difficult and cannot be practised as a general method.

So far my object had not been attained. I wanted to find out a method of grafting by which the variety of any existing plantation can be changed at will. A new plantation can be put up by growing together and training mixed cuttings of different varieties, and when the heads are formed, the choice variety may be grafted upon another stock by the approach method. I have obtained a few grafts in this manner. But it takes up much time to train the vines before they can be grafted upon and, therefore, foreign varieties cannot be propagated rapidly by this method, nor can their possibilities judged within a short time. Crown and side-cleft grafting have a greater significance in the case of untried and foreign varieties ; for, by these methods, these varieties can be introduced rapidly and their possibilities judged.

RESULTS.

As a general rule, Fakari vines on their own roots bear quite indifferently. They will not bear fruit at all or bear a few bunches which are quite out of proportion to the large bearing surface on the head of the vines. All the grafts are bearing fruit regularly from the second year. The quantity of fruit will depend on the bearing surface. As the age of the grafts

advanced, the heads were well formed and the bearing surface had increased. There was a corresponding increase in the number of bunches and the weight of the fruit. I am writing this from my observations. I have not kept regular records. Last year the weight of fruit on the graft (approach graft of 1913,) must have been 15 lb.; the other approach grafts yielded nearly seven pounds of fruit; the two crown grafts bore quite to my expectation. This year the approach grafts of 1913, had 42 bunches, which weighed 22 lb. (Birds are responsible for considerable loss of weight; only actual weight is given). The other approach grafts had 19 bunches which weighed 14 lb. The number of bunches on the crown graft of 1914, was 17 and weighed 7½ lb., while the other crown graft of 1915, gave 13 bunches which weighed 6 lb. The bunches on both the grafts were mildewed, which circumstance has adversely influenced the weight. Many of the bunches were of large size. The berries attained normal size. On the other hand the berries on some bunches were undersized. Near each crown graft (close to it) is a companion or sister Bhokari vine which is also in bearing. In one of my plantations there are 150 Fakari vines on their own roots. They bear fruit indifferently and are not even paying the cost of their cultivation. This is the first time in five years that they have borne fruit to an appreciable extent. The total weight of fruit on these 150 Fakari vines was 196 lb., or a little less than 2 lb. per vine. The average yield from Bhokari vines is 12 lb. to 15 lb. Individual Bhokari vines do bear 20 lb. to 25 lb. of fruit. From these figures it will be seen that the grafts gave considerably increased quantity of fruit, far in excess of the average of 2 lb. on the 150 Fakari vines on their own roots.

CONCLUSION.

It appears that grafting the grape-vine increases fruitfulness. The grafts give larger and closely-set bunches. In some bunches the berries attained normal size, while in others they are undersized. The quality of the fruit is not changed appreciably. From the behaviour of four grafts, it is not safe to assert, as a general proposition, that grafting produces fruitfulness. The indications are, however, that it does produce increased fruitfulness. More experimental work is necessary. Experiments generally do not pay and are even costly. In other experiments with the grape-vines—such as summer pruning or pinching and spraying with ammonia copper carbonate solution against mildew—I have gained; while in trying the crown grafts, I have lost 40 well-established vines and permanently injured 40 vines by side-cleft grafting. Besides, such experiments in experienced and capable hands are likely to be more successful. If the record of my experiments be deemed interesting, I hope others will undertake further experimental work.

Next cold weather, I shall grow and train 60 sets of mixed cuttings. Every set will consist of 4 cuttings, two of Bhokari and two of choice variety. Bhokari will be used for stock. For the scion, cuttings of Fakari, Sahibi, Kali and Kandabari will be grown.

When the vines are established and heads are formed, I propose to graft the choice varieties by the approach method.—AGRIC. JOUR. OF INDIA, Vol. xiv, Part I.

GOOTEE-LAYERING AT SCHOOL GARDENS.

In most school gardens, but particularly in the dry districts, are to be found a number of well-grown orange and lime trees from plants supplied by the Government Stock Garden. The majority of these trees are of the best varieties and are therefore well worth propagating.

Propagation from seed is not always reliable because of the fact that the flowers of the orange and lime are sometimes fertilised by the pollen from inferior varieties, and many instances have occurred of seeds from the fruits of a good variety of orange producing trees that yield inferior fruit.

For this reason it is best to propagate the orange and limes by budding, grafting or layering so as to ensure the qualities of the parent tree being reproduced.

The most convenient and successful method is by what is known as gootee-layering, which is easily carried out :

Select a branch to be operated on and remove from it a small ring of bark, or make a slanting deep upward cut. Do this, if possible, just below a leaf bud or node. Then apply to the cut part a ball of clay, envelope this in coir fibre, and bind the whole round firmly with coir yarn. Keep the part moist by an occasional watering.

In three or four months young roots will be observed in the gootee ; then the new plant may be severed from the parent tree and planted in the place prepared for it.

By this operation (which is best carried out in wet weather) branches bearing flowers and fruit can be established as independent plants without even the leaves withering.

Teachers should teach this interesting mode of propagation to the school children and explain its importance.

In any case of difficulty or doubt, the Inspector of School Gardens when he visits the school, can be consulted.

C. DRIEBERG,
Superintendent, L.C.P., & S.G.

BANANAS AS A DILUENT FOR WHEAT FLOUR.

In the *Proceedings of the Agricultural Society of Trinidad and Tobago*, September 1918, in an article on the banana, it is stated that the local Department of Agriculture has done good service in popularising the use of green bananas as a diluent for wheat flour in bread. Many recipes have been recommended, but the following seems to be worth a trial on account of its simplicity : Boil green bananas in salted water, and when thoroughly cooked, pour off the water, mash the bananas, and to 30 % of that mash add 70 % of flour dough, this will produce a bread of very palatable quality. AGRIC. NEWS, Barbados.

SOILS AND MANURES.

THE VALUATION AND PURCHASE OF MANURES.

H. L. VAN BUUREN, (Jr).

The high cost of imported manures and the fact that some popular manures are not in stock suggest that an attempt to ascertain the current market price of the unit of Nitrogen, Phosphoric Acid and Potash will be helpful in deciding whether manuring programmes should not be resumed.

The accompanying list gives the manures now stocked by firms with their prices per ton and guaranteed analyses. To this is added a column where the unit values of the actual plant-food present in the respective manures are calculated.

The unit taken is one-hundredth of a ton and the unit cost is conveniently obtained by dividing the price per ton of the manure by the percentage of the actual plant-food the manure is guaranteed to contain. Thus castorcake is guaranteed to contain 4½ % nitrogen. By dividing the cost per ton i.e., Rs. 125/- by 4½, we obtain the unit value of nitrogen in castor cake.

Manures.	Per ton Gross f. o. r. Colombo.		Guaranteed Analyses.			Unit Values.		
			Nitrogen.	Phos. Acid.	Potash.	N.	P.	K.
	R.	c.				R. c.	R. c.	R. c.
Castor-Cake ...	125	00	4½	...	...	27 78	...	...
Groundnut Cake ...	145	00	7	...	...	20 71	...	...
Crushed Fish ...	120	00	4	4	...	20 71	9 29	...
Fish Guano ...	160	00	8	8	...	17 14	2 86	...
Bone Meal ...	125	00	3	22	...	20 71 17 14	2 86 3 34	... ...
Std. Bone Meal ...	130	00	3	22	...	20 71	3 09	...
Basic Slag, 80 % fineness ...	150	00	...	14/16	...	...	10 71 9 64	...
Burnt Lime ...	37	50	...	...	...	...	...	...
Blood Meal ...	360	00	12½	...	...	28 80	...	...
Potash ...	225	00	...	...	20/22	...	...	11 25
Superphosphate ...	130	00	...	18	...	...	7 22	...
Animal Meal ...	235	00	7/8	7/8	4	17 14 17 14 25 37	11 09 2 86 2 86	9 35 23 75 9 35
Nitrate of Soda ...	500	00	15	...	...	33 33	...	...
Nitrate of Potash ...	480	00	10	...	33	33 33 17 14		4 44 9 35

OIL CAKES.

A survey of this list shows that of the oil cakes the unit is dearer in castor cake than in groundnut cake—a fact that most planters who manure with castor cake are perhaps not aware of. Otherwise there seems to be no valid reason why castor cake should be preferred to groundnut cake. Some planters assert that groundnut cake attracts ants which generally carry away a large proportion of the manure to their nests, and this is thereby lost to the trees. It is doubtful whether this is so serious an objection to the use of groundnut cake.

Coconut poonac has once again reverted to its original use as a cattle food. Through the courtesy of the Manager of the Colombo Commercial Company, Limited, the following information is available :—" Coconut poonac under normal conditions is shipped in large quantities to Europe for cattle feeding. It is doubtful if it could be purchased to-day under Rs. 90 per ton, f.o.r. Colombo, and as it analyses only 3·30% of nitrogen and frequently less than this, it would not pay to use it as a fertiliser. We have been informed that one objection to using it as a fertiliser for tea is the percentage of free coconut oil in it which has a deleterious effect on tea plants. Of course we cannot vouch for this."

The unit value of the nitrogen of cocount poonac sold at Rs. 90 per ton and a guaranteed analysis of 3% N works out at Rs. 30. This is much dearer than what the unit is in castor cake and even in blood meal, but the unit is still cheaper than that in nitrate of soda. With the present prices it may be said that coconut poonac will not pay to apply as a manure unless it is available at Rs. 50 per ton. At such a price the unit is a little cheaper than in groundnut cake. With regard to the deleterious effect of the oil in the poonac on tea plants this is "not proven," the evidence we have at present not favouring such an idea. Oil, in a manure, has a detrimental effect, indirectly, in that it hinders the action of soil water and delays the decomposition of nitrogenous substances.

FISH MANURES.

When we consider the fish manures available, we see clearly how utterly worthless it is to buy crushed fish. This manure consists of the dried sardines crushed without removal of the oil. The manure is not pleasant to handle and when the unit of nitrogen is calculated as equal to that of groundnut cake, it is seen that we pay too dear a price for the unit of phosphoric acid.

Fish guano is free from all these objections, nearly all the oil is expressed rendering the plant-food more quickly available and the high content of nitrogen and phosphoric acid make the manure a very cheap one.

If we calculate the unit of nitrogen as equal to that of groundnut cake, we find that the price per ton is much less than its value on this unit alone. When we calculate the unit of phosphoric acid as Rs 2·86, then the unit of nitrogen works out at as only Rs. 17·14, by far the cheapest unit available on the market. It is instructive to compare this with prices before the war. Then the unit was cheapest in Sulphate of Amonia which was selling at Rs. 250 per ton and a guaranteed analysis of 20 % N. This gives the unit value as Rs. 12·50. Next in cheapness was groundnut cake which was selling at Rs. 110 per ton and a guaranteed analysis of 7 % N. This gives a unit value of Rs. 15·71.

It is seen then that the unit value of nitrogen in fish guano is only Re. 1·43 dearer than the unit of groundnut cake before the war. A very favourable comparison. The other nitrogenous manures are blood meal and nitrate of soda, in both of which the price of a unit of nitrogen do not justify purchase. Nitrate of soda is practically double the price before the war.

PHOSPHATIC MANURES.

Now, taking the phosphatic manures, it is seen that bone meal is cheaper than steamed bone meal. It is exceedingly doubtful whether the fact that the stuff has been steamed and ground somewhat finer (as a sample suggests) justifies the slightly higher price. Steaming is generally known to make a larger proportion of the phosphoric acid soluble. The whole of the mineral framework of a bone is permeated with cartilage consisting of nitrogenous compounds. These nitrogenous substances are converted into gelatine in the steaming process and can be dissolved and separated out as glue. Where this steaming is done at a high pressure and temperature, the bone residue after the process will be found to contain roughly half the nitrogen it formerly contained. The fact that the nitrogen content remains unchanged, being the same as in ordinary bone meal, would appear to suggest, that such extraction has not taken place, consequently the phosphoric acid can hardly be said to be rendered more soluble. Even if the phosphoric acid is more soluble, it is extremely doubtful whether under tropical conditions and for such tropical crops as coconuts, tea and rubber, such forms of phosphoric acid are of value. Many manures classed as slow-acting under temperate conditions may decompose sufficienly rapidly as to be available for the crops in question.

On such grounds the purchase of superphosphate, at any rate at the present time, does not appear justifiable. Superphosphate is nearly 75 % dearer than what it was before the war. Besides, if such a quick-acting manure is needed, it is preferable to buy the concentrated superphosphate, where the percentage is raised to 42 %. This is not available now, but before the war it was 51 cents cheaper per unit than the superphosphate containing only 18 % of soluble phosphoric acid.

The unit of phosphoric acid in ordinary bone meal is Rs. 2·86 when the unit value of its nitrogen is the same as groundnut cake. Calculating the unit value of its nitrogen at Rs. 17·14, the unit value of phosphoric acid works out at Rs. 3·34.

This shows that the unit is cheapest in fish guano not only for nitrogen, but also for phosphoric acid. This makes fish guano a very important manure and one deserving of notice at the present time. Before the war, the unit of phosphoric acid was cheapest in ordinary bone meal which works out at Rs. 2·84 when the nitrogen unit value is calculated at Rs. 12·50. (Ordinary bone meal was selling at Rs. 100 per ton with the same guaranteed analysis as now given. Rs. 12·50 is the unit value of N. in sulphate of ammonia).

It will be seen then that the unit of phosphoric acid in fish guano at the present time is only 2 cents dearer than the unit value of phosporic acid of ordinary bone meal before the war began. Only one other manure needs mention here, that is basic slag. It will be seen that its unit value of phosphoric acid is very high. The lower value is calculated on the assumption that basic slag contains 40 % lime and assuming that basic slag will be applied as a manure on soils needing lime. Even in such circumstances, basic slag is too expensive a phosphatic manure to be even thought of at the present moment.

POTASSIC MANURES.

The potash that is presently sold is very expensive; before the war, the unit of potash in muriate of potash was Rs. 3·19, in sulphate of potash (50% K_2O) Rs. 3·70, in Kainit, Rs. 5·00 per unit of potash.

If we calculate the unit of nitrogen in Nitrate of Potash as Rs. 33·33 (the same as Nitrate of Soda), then the price of the unit of potash works out at Rs. 4·44—a very favourable comparison with pre-war prices.

If we calculate the unit of nitrogen at Rs. 17·14, i.e., the cheapest on the present market, then the unit of potash works out at Rs. 9·35, working out even in this case cheaper than the potash now sold with a guaranteed analysis of 20/22 % K_2O.

We come to the important conclusion then that whilst in Fish Guano we have the cheapest nitrogen and phosphoric acid available on the market, we have similarly in Nitrate of Potash the cheapest nitrogen and potash presently available on the market.

Before closing this interesting analysis, a word is necessary about Sterilised Animal Meal. The first line shows that if the unit value of nitrogen and potash are calculated at their value in fish guano and Nitrate of Potash, the unit of phosphoric acid is the dearest on the market. If the unit of phosphoric acid and nitrogen are calculated as that of fish guano, the unit of potash is more than double the unit of potash in the dearest potash available. If the unit of phosphoric acid and that of potash is calculated as that in fish guano and Nitrate of Potash, then the unit of nitrogen is only a little cheaper than that in castor cake and dearer than that in fish guano and groundnut cake. On these grounds, there appears to be no reason why even with the present high prices, any one should buy sterilised animal meal.

THE POTASH INDUSTRY.

A FORMER GERMAN MONOPOLY.

GILBERT R. REDGRAVE.

The trade in potash, which has become one of world-wide importance, was at the outbreak of the war almost entirely in German hands; and so confident was Germany that we should eventually have to come back to her for this commodity, that it has often been stated by the experts in that country, and it was a favourite saying of the Kaiser, that England and the Allies would be compelled to sue for German potash after the war was over. In fact this was considered to be one of the powerful economic levers by means of which Germany might secure from enemy countries the necessary supply of raw materials for her various industries.

Potash is widely distributed in Nature and forms an important constituent of large portions of the earth's crust. It is found in the form of soluble salts in nearly every fertile soil, and great stores of it are contained in sea water. It is an essential part of the food of plants, and passes from them directly into the bodies of animals. Formerly, indeed, one of the best known sources of potash was the *suint*, the grease from the wool of the sheep, and it was also obtained from the ashes of plants and from calcined seaweed Associated with sodium nitrate, it occurs in large arid tracts in South America as an efflorescence on the soil.

THE STRASSFURT DEPOSITS.

About sixty years ago the rock-salt beds of Strassfurt in Germany began to attract attention, and valuable deposits of potassium minerals were found at depths of about 850 feet below the surface. Other still more prolific beds were reached at a depth of some 1,100 feet, but the rock itself and the brine or deliquescent salts of this District also proved to be a rich source of potash; and so cheap and so abundant were the products of Strassfurt that all other potash manufactures had to be abandoned. While the rock-salt works are mainly Government property, the chief chemical factories are in private hands, and the output of potash in recent years, or shortly before the war, became so large as to need some regulation in order to avoid a glut in the market. It was asserted in 1910 that the daily flow into the Elbe of magnesium chloride and common salt, which were the waste liquors from this industry, represented a weight of chlorine alone estimated at 975 tons, and rendered the

water of that river distinctly saline to the taste. In view of the flourishing state of the industry at Strassfurt, Germany naturally saw no need to encourage development in Alsace.

In 1904 extensive deposits, resembling in all respects those of Strassfurt, were discovered in Alsace over an area of about seven square miles, North-West of Mulhouse. The estimated available quantity in this locality is 300 million tons, and some fifteen shafts have already been sunk, though production has hitherto been much hampered by various legal and other restrictions consequent upon German ownership of the land.

NEW SOURCES OF SUPPLY.

Notwithstanding the large stocks of potash in the hands of the trade, when the supplies from Germany were cut off by the war, this country, and indeed the world, was faced with a famine of a substance that is needed by the agriculturist and for many Military purposes as also for the manufacture of matches. It thus became necessary to consider the possibility of new sources of supply.

In speaking of the imports of potash, this word is used in several different senses, and it is not an easy matter to arrive at definite figures. It is alleged that in 1913 Germany exported 1,800,000 tons of potash of which 865,000 tons went to the United States, 150,000 tons to Great Britain, 95,000 tons to France, and smaller amounts to other continental countries. It seems likely that much of this potash was in the form of "kainit," an impure sulphate containing also common salt and magnesia salts. The custom of the trade was to sell kainit on the basis of its contents of soluble potash, with a guaranteed percentage of not less than 12 per cent. soluble. Worked out on the unit value, potash fetched a retail price of 4s. 6*d*. to 4*s*. 9*d*. per unit (£22 10*s*. to £23 15*s*. per ton,) while potash sulphate was priced at 2*s*. 6*d*. per unit (£12. 10*s*. per ton) and on this basis kainit, with about 12 units of potash, cost 54*s*. to 57*s*. per ton. Since August, 1914, potash has gradually risen in price, until in October of the present year it fetched 26*s*. per unit (£130 per ton). This would place kainit, if procurable, at £15 12*s*. per ton.

As already mentioned, potash has been extracted in considerable quantities from greasy fleeces, and in February reference was made to the attempts being made at Bradford to deal with this source of supply.

Another source of potash is the flue-dust from cement works, blast furnaces, and coking plants. Considerable progress has been made in America in treating the dust deposited from rotary cement kilns for the recovery of this substance, and it has been suggested that an increased yield might be obtained by adding feldspar to the cement constituents. In this country the Government has taken steps to deal with blast-furnace flue-dust, and the Board of Agriculture & Fisheries has issued a "leaflet" on the subject, setting forth the prices to be charged from June, 1918, to May, 1919. The charges would appear to contemplate a range of potash contents from 2 to 14 per cent., and the price is estimated at from 7*s*. 6*d*. to 8*s*. 6*d*. per unit. Flue-dust, containing 12½ per cent. of potash is valued at 117*s*. per ton. This would be equivalent to 9*s*. 5*d*. for the unit of potash and 5*s*. 6*d*. per unit of potash sulphate.

FELDSPAR AND ALUNITE.

In a paper by MR. E. A. ASHCROFT, read before the Institution of Mining & Metallurgy at the close of last year, it was stated that it is possible to manufacture from potash feldspar, fused in closed receptacles with an equal weight of common salt at a temperature not exceeding 1,000 deg. C. a product consisting of finely-divided insoluble sodium feldspar and a mixture of quite neutral and freely soluble sodium and potassium chlorides. The author maintains that this simple process is, under proper conditions, capable of industrial application. Vast quantities, estimated at 12 million tons, of minerals said to be suitable for the purpose, have been found in Sutherlandshire.

Much attention has been directed in America to the utilisation of feldspar as a source of potash, and more than 100 patents have been secured for various modes of working. Other American sources of potash are found in the Lakes at Lincoln, Nebraska, where a thick coat of cream, floating on the surface, is said to yield potash in abundance. The Consolidated Gold Fields of South Africa claim to be producing over 43 tons of potash per diem from their workings under the Trona Corporation at Searless Lake, California.

All these supplies, however, sink into comparative insignificance beside the vast beds of alunite at Bullahdelah in New South Wales, and the deposits at Warnertown and Carrickalunga in South Australia. It is estimated that in the first-named rocks at least 200 million tons of this mineral are in sight, in cliff form, in the outcrop. It is said that by calcination of the alunite, which is obtained by open workings, large quantities of the fertiliser containing about 16 per cent. of potassium sulphate could be prepared on the spot.—Times Trade Supplement, Dec., 1918.

DUNG HEAPS AND THE PRESERVATION OF FARMYARD MANURE.

Farmyard manure, whether it is to be used in spring or in autumn, should always be carefully kept. At present, owing to a shortage of artificials, the need for this care is all the greater.

SPRING MANURING.

In Northern Districts of high rainfall, spring manuring is the general practice. There, most of the dung is employed on the root shift, the greater part of one season's "make" being applied in the drills in spring. During frosty weather most of the dung is carted to the field where it will be required and heaped in "middens." Sometimes short dung is scattered on to the stubbles in autumn direct, and ploughed in ; this is generally the small proportion which has been left over from the previous spring, after the root land has been manured, and, although it is recognised as being less efficient than longer dung applied in spring, its use in autumn reduces the pressure of work in the following spring and is justified on that account. This manure will either have been left in the yards or heaped in the fields somewhere handy for the stubbles.

AUTUMN MANURING.

In Southern Districts it is the custom to apply the greater part of the manure in autumn and winter, in preparation for wheat, roots or potatos. The dung in this case consists mainly of what has been made in the yards in the previous winter ; consequently the interval between the making and the application, and, therefore, the opportunities for waste, are greater than in the Northern practice. The dung is, if there is room, sometimes left lying in the yards till it is required after harvest, then carted out and spread on the land and ploughed in at once. On farms where there are covered or partly covered yards this is probably the best plan, provided the manure is prevented from becoming dry. There is no great difficulty in ploughing in such manure.

But to save time in the busy autumn months and to get the dung shorter, the yards are often emptied during frosty weather in late winter or in slack times in summer, and the manure heaped somewhere handy, either in the "seeds" field intended for wheat or potatos or in readiness for the stubbles. In either case the manure is afterwards spread broadcast and then ploughed in.

DISADVANTAGE OF "SHORT" DUNG.

There is no doubt that "short muck" is easier to handle, but it must be remembered that such material is the result of fermentation, and fermentation means loss of plant-food. Much of bulky material wastes away and is lost ; the residue is less able to retain the liquid, and this also tends to disappear.

CARE IN PREVENTING LOSS FROM MANURE.

Whether the Northern plan of applying manure in spring or the Southern plan of applying it in autumn be followed, it is most important that when dung-hills are made in the field or anywhere else there should be as little loss as possible. The art of making a dung-heap seems in great measure to have been lost, and the once common and efficient "cart-over" or "draw-heap" is now seldom seen.

MAKING A DUNG HEAP.

Bottom of Heap.—If the breadth decided upon is 15 ft., the first cart-loads should be dumped in a row across the whole breadth ; these loads should not be spread out thinly. The second lot of loads are laid in the next row across the breadth, and so on, the carts always passing over the loads previously laid down until the proposed length is reached. Thus the bottom is built.

Following Layers.—The next layer is formed in the same way, only each load after being dumped is well spread out, and the middle of the heap is kept slightly higher than the ends ; the carts thus pass up an incline at one end and down at the other, till the whole is well-trodden and compacted by the carts and horses.

Finishing Off.—When the dung-hill has reached the required height, the thin sloping ends and any loose dung along the sides should be thrown on top and trampled down, and whole top then brought to a gentle ridge. It should be covered with a layer of earth, about 6 in. thick, and with straw-matched hurdles if these are available, but it is wasteful merely to cover loose dung ; it should first be firm and solid. The object of making the heap firm is to prevent air getting in and causing fermentation. Just as, with fire, too much air waste coal, so, with a manure heap, too much air wastes plant-food.

SIMPLE RULES FOR DEALING WITH MANURE.

1. Until it is wanted for use, leave it where practicable under the beasts, if possible in a well-covered yard.

2. Never throw it out in loose heaps.

3. Move it about as little as possible. If it has to be moved store it once for all in a solid heap as near as possible to the place where it is to be used, and shelter it from rain.

4. After breaching the heap, waste no time in ploughing the dung in. Don't leave manure lying about in small heaps.

5. Try to avoid keeping manure during the summer—it is hotter then, and heat means waste.

6. Keep all the liquid in it ; don't let it drain away. If it must drain away, let it drain into a properly-constructed liquid manure tank.

7. Remember that the two things that spoil manure most are air and rain, so keep it well protected from both.

8. And remember that every little bit of extra care taken means both an advance in good farming, and what is more important at present, an increase in food for man and beast.

9. Use litter as freely as supplies will allow ; it not only makes for the comfort of the animals and produces more manure, but there is evidence to show that it minimises the losses of ammonia.—JOUR. OF THE BOARD OF AGRICULTURE, Jan. 1919.

FIBRES.

THE OLONA: A VALUABLE HAWAIIAN FIBRE.

The ever-increasing demand in the world's market for fibres gives interest to the following extract from an account of a possible valuable source of supply of fibre of the finest quality by Vaughan McCaughey, of the College of Hawaii, published in Science, September 6, 1918.

The Hawaiian people formerly made use of a considerable range of fibre plants. Some of these were brought by the natives from the South Pacific, others were discovered in the new island home. The paper mulberry (*Broussonettia papyrifera,*) is an excellent example of a fibre plant widespread in the Pacific region. From its copious bast was made the typical "kapa" or bark-cloth of Polynesia. Olona (*Touchardia latifolia.*—Gaud.,) on the other hand, is wholly confined to the Hawaiian Islands, the genus is monotypic and endemic. The ancient Hawaiians undoubtedly discovered the valuable fibre of this plant at a very early time. They were intimately familiar with the local flora and its economic utilisation. The olona is mentioned in many of the old songs and legends.

Special interest is attached to the olona fibre, as it is generally recognised to be the strongest and most durable fibre in the world. No other fibre is recorded to exceed it in these two important characteristics.

The natural habitat of the olona is the lower and middle forest zone, lying on the mountains between elevations of 800 to 1,000 feet. It is strongly hygrophytic and shade-loving ; it never occurs naturally in the open or in dry sections. The favourite habitats are deep, cool, gloomy ravines, or moist slopes that are well screened by forest cover. The olona belongs to the ecologic section of the Hawaiian flora that luxuriates in the dense moist shade of the montane forests. It occurs in little patches and thickets here and there in the forests, but is nowhere abundant. It does not form continuous stands ; reproduction is not vegetative, but apparently always from seed. In any spot the collector is not likely to find more than a few score of individual plants.

The Hawaiians formerly cultivated the olona in a primitive manner. They did not prepare the land or plant seed, but merely searched out good patches of the wild plants. Such a patch was cleared of any obstructing vegetation, not disturbing, however, the large trees which shaded the plants. If the olona plants were too crowded they were thinned out. The old plants were pruned so as to give a number of young, straight shoots.

At irregular intervals, as convenience or necessity dictated, the grove was visited and the crop harvested. This process consisted in cutting all the long, straight shoots that had reached a diameter of about 1 inch. The bark of such shoots was rich in bast fibres, and these were of maximum length. Six feet was an average length. The bark was carefully stripped from the wands, in one or more pieces, packed into rolls or bundles, and carried down to the settlements on the lowlands, where the final operations were performed.

A suitable situation was found along a stream or irrigation ditch. The bundles of bark were opened out in the shallow running water, where they were allowed partially to macerate. This required several days ; then the long strips were removed from the water, and the remaining pulpy matter was scraped from them while still wet. The scraping was performed on a long, narrow, hardwood board, specially devised for this purpose. The prepared fibre was carefully dried and rolled into cordage of various sizes.

Among the Hawaiians it was put to a great variety of uses. All fishing-lines and nets of the best quality were invariably made of olona, because of its high resistance to the action of salt-water. Olona lines and nets which have been in more or less constant use for over a century are almost as good as new, and are handed down from generation to generation as precious objects. Most of the natives are very unwilling to part with any of their fishing-gear that is made of olona.

This fibre not only partakes of all the best characteristics of this genus, but is superior to any other of its members, producing the best of all fibres known at the present time. The three dominant features are :—

First.—The great tensile strength. The strength of olona is estimated at about three times the strength of commercial Manila. The statement is made that olona is about eight times as strong as the hemp *(Canabis sativa)*. So far as I can gather, this great strength is due to the unusual length of the cell in proportion to its width.

Second.—Its great resistance to deterioration in salt-water. A ball of olona fish-line, the Hawaiian owner of which stated that it had been in their family, and in constant use, for over fifty years, has been examined, and the fibre was still in an excellent state of preservation.

Third.—Its pliability, and thus its adaptability for spinning by hand. Fishing-lines and nets made from this fibre by expert Hawaiians present an appearance of so uniform a calibre and twist that it would lead one to believe that the fibre had been made by the most intricate machinery.

A fibre with these characteristics should be exploited to the fullest measure. The extraction of this fibre is not a difficult process.

The key to the situation lies in transforming this plant from its wild state to a cultural form. When this is done, the world will be in possession of a new fibre, having a greater tensile strength, weight for weight, than any other fibre known.—AGRICULTURAL NEWS, Nov. 2, 1918.

AGRICULTURAL EDUCATION.

MATERIALS FOR A POLICY OF AGRICULTURAL EDUCATION.

H. M. LEAKE, M.A., F.L.S.

(Economic Botanist to the Government and Principal, Agricultural College, Cawnpore.)

Myself when young did eagerly frequent
Doctor and Saint and heard great Argument.
About it and about ; but evermore
Came out by the same Door as in I went.

In perusing the voluminous literature, which has arisen on subjects educational, the quotation which heads this paper comes somewhat forcibly to the mind. I am not oblivious to the retort that this statement obviously raises, namely, why then add to that volume ? I have failed to find an answer which satisfied myself, and am fain to admit that it is probably of the same tenor as that to the riddle of our childhood—the riddle I do not remember, but the answer was to the effect that the other donkey did so too. There are certain thoughts, however—perhaps, more suitably termed criticisms—which so constantly arise in such perusals that I am tempted to assume the *rôle* of the other donkey and commence with a few general observations which will lead on to the more special subject of agricultural education.

In all educational institutions, we have two factors—the pupil and the teacher ; the former, owing to the system of teaching in classes a multiple, the latter a single, intelligence. This condition too often offers the mental equivalent of a boat's crew. In training a crew for a race the coach has to think of the crew as a whole and attempt to raise the average physical fitness to the highest point on the day of the race. For this purpose, certain members will be over-trained or "stale," others under-trained. The system, of training, consisting as it does, or did in my own college days, of combined exercise in the boat, and individual exercise, known technically as swinging, affords a certain amount of latitude in adapting this system to the individual capacities of the oarsmen. Add to this the fact that the rowing age is an age of discretion, where the oarsman is capable of interpreting his own feelings and expressing them to the coach, and it becomes clear that the training for a race is a system interpreted by a coach, or teacher, who is aided and checked by the intelligence of the individual members of his crew. The similarity of the conditions of the teacher with his class, to those of the coach with his crew, is sufficiently near to mask the essential and great differences, and this similarity is emphasized by the examination system which fixes a culminating point for the education. For, just as the crew is judged by the result of the race, and as the coach attempts to have his crew in the pink of condition on the day the race is rowed, so the teacher attempts to have his class so mentally equipped on the day of the examination that it will show to the best advantage. To do this he, too, adopts a

system and, to the extent that the class system, by which the pupils are distributed to him, and the examination system, by which he and his pupils are judged, become standardized, that system also becomes standardized, and impersonal.

The force of the comparison, however, lies not so much in the points of of similarity as in the differences, and this aspect will repay a brief consideration. The crew is judged by its combined effort which is the resultant of the individual efficiencies of the members of the crew. In the case of the examination, on the other hand, there is no combined effort—the individual efficiencies are interdependent, and the teacher will be judged differently according as major stress is laid on the average number of passes or on the standard attained by the most intelligent pupils. This difference may be expressed in another way. While the judge at the winning post of the boat race has no personal influence on the result of the race, and, through it, on the coach and the system of training, the judge in the examination, in other words, the examiner, according as he frames his questions and considers the answers to test the general standard of the class or to pick out the best pupils, will have a material influence on the teacher and his system of teaching. Of the former type, the examinations, as conducted in this country, are perhaps the most typical examples, while, of the latter, the scholarship examinations, as conducted at the older English Universities, afford a good illustration. The former appear to be the sounder, in that it will aim at the maintenance of an average standard of the combined teaching, within the understanding of all the students, about which individual exercises, adapted to the individual intelligences, can be built. The latter type of examination forces the standard of the combined teaching to the level of the highest intelligence—too far above the level of the weaker intellects for any system of indivldual exercise to be of value.

Again, I have stated the members of the crew have reached an age of discretion. They are in a position to judge by their feelings their physical fitness; they can convey those feelings to the coach who can modify the individual training accordingly. The pupil is in no such enviaole position. He is not a judge of his own mental condition and the teacher is, thus, to this extent at a disadvantage, when compared with the coach, that he has to interpret his instruction in terms, not of his own intelligence, but of that of his pupils. This, to my mind is a point rarely realized and realized with the utmost difficulty. Again and again I have listened to reasoned and logical arguments on courses of instruction, the reason and logic of which, however, appeals to the adult mind, and I have found it impossible to avoid wondering, as I listened, whether the speaker had not assumed in his pupils, a mind as logical and as accustomed to reasoning as his own. The danger is, in fact, very real that, in evolving a system which is reasoned and logical, the teacher is evolving one which, by that very fact that it is reasoned and logical, will appeal to the adult and not the pupil mind. He has, in fact, failed in one of the main functions of a teacher, and he lacks the capacity of projecting himself into the position of the pupil.

There is yet a third difference in the comparison I have drawn. The coach's efforts are concentrated on the race and on turning out his crew on the day in a condition as near physical perfection as possible. It is no concern

of his if, on the evening after the race, the stroke dines not wisely but too well, and is later arrested for obstructing the police ; nor does he care if another member of the crew spends the rest of the day smoking till he becomes ill. The teacher is in a totally different position with his pupil. He does not, or should not, lose interest in his pupil on the day the examination result is published, though this is perhaps too frequently the case. A teacher who does this is not worthy of the post, and it is only necessary to consider one of the objects of education, and that is, to render the individual a useful citizen, to make this clear. Education has missed one of its main functions if it wlll not prevent the man who successfully passes the final examination from developing into a pick-pocket.

By the above comparison, I have attempted to bring into prominence one aspect of the educational problem, and one which is frequently overlooked, namely, the insignificance of the system compared with the individual. My statement that this aspect is overlooked may be called in question, and it is true that recognition is frequently accorded to the point. I cannot help thinking, on the other hand, that, in this country, as in others, in the distribution of educational finance and in the grants lavished by Government for educational development, which are largely earmarked as non-recurring and are devoted to the erection of new school buildings, too much attention is given to the numbers of schools teaching a standard curriculum, and too little to that improvement of the pay and prospects of the teachers, which alone will attract a better class to the profession, and thus remove the necessity for that rigid standardization which stultifies the individual initiative—so essential to the real education—of the teacher.

The above considerations are of general application ; that is they apply to the educational problems of any country, but from this point, my argument proceeds along two lines, and deals more particularly with the problem as it appears in this country. The first of these deals with the type of education, as influenced by the conditions of the country, the second with the limitations imposed by the system of educational finance.

One of the functions of education has been already stated, namely, to render the individual a useful citizen. That may be a highly materialistic aspect, but the modern world is materialistic and a country, if it is not to be left behind in the international race, must be materialistic. It is difficult, if not impossible, to find a brief definition, which will cover each and every function of education, and the above will, perhaps, serve as well as any for a starting point. Now it is obvious that the world would not be a satisfactory place to live in, if everyone were educated to the clerical profession. The clerk is a useful person, but once the number exceeds that necessary to carry on the essential clerical work, there must be a number of persons who are failing to fulfil that function. It may be that there is here a confusion between education and training, but I think not, though I admit the line of demarcation between the two is not readily drawn. Education then, considered from a national aspect, must be diverse, and, in its practical aspect, consists in placing before the youth of the country the essentials for the devolepment of the mind in a form which will leave the individual in a condition in which he will render useful service as a citizen. In former times

the guiding factor in the choice of a profession was mainly parentage, the son following the trade of the father, and this is still very largely the case, especially in more backward countries. But modern thought—the result of compulsory education—is increasingly in favour of equality of chance, irrespective of birth. Within wide limits, therefore, the diversity of education should be so disposed as to place within reach of each individual a form of education suited to his probable future life. A more detailed consideration of the true meaning of this statement is desirable, since it is here, I think, that the fallacy contained in the modern claim for equality of chance, and in the various economic doctrines arising therefrom, is most readily exposed.

In the various professions by which the individual earns a livelihood, the labour expended is rewarded in very different measure in the apportionment of worldly goods, and, with the materialistic aspect of modern life, the professions tend to be judged by this standard and to be desirable in proportion to the measure of these goods received. Equality of chance in practice, therefore, implies a claim on the part of every individual to an education fitting him for the most lucrative profession. Now it is perfectly clear that the world would not be a fit place to live in if every individual were educated for the legal profession. Food and the thousand necessities of modern life have to be produced by human labour, and for that labour the education I have taken, as an example, is unsuited. Equality of chance, therefore, is not obtainable by the provision of an education, qualifying for the most lucrative fields of employment. The alternative, the equalising of the reward, while perhaps not theoretically unsound, is practically unattainable. It is only necessary to attempt to picture the economic condition of a country in which the farm labourer receives, say Rs. 1,000 per mensem,* to understand how far we are from obtaining equality of chance by this means. The fact is such equality is an ideal, probably undesirable and, certainly, practically unobtainable. Labour of the brain always has been, and will continue to be, more liberally rewarded than labour of the hands, though change may occur in the degree of divergence. Equality of chance is, thus, a fallacy; nevertheless the idea has an underlying basis of truth. That truth is, I think, this: While, for the majority, it ts desirable that an education shall be provided which will fit them to fill the station they are most likely to occupy in life, namely, that into which they are born, modern thought demands and rightly demands, that the individual should not be bound by the accident of birth. Far from this meaning that each individual has a claim to the highest form of education, it implies that a ladder should exist by which individuals in any particular station can ascend, if so fitted, to a higher one. Advancement is, thus, not an inherent right, but the reward of merit. One error running through educational discussions and educational schemes is the misplacement of these two objects of education—the conversion of the ladder provided for the gifted to a broad staircase for the mediocre. The effect of this error is to be seen in most countries, but in none, perhaps more so than in this. The average individual is led to expect, regardless of economic laws, an education fitting him

*The same condition will be reached by assuming the High Court Judge to be paid Rs. 7 per mensem, the essential fact being the relation between cost of production and purchasing capacity—that is, relative, and not absolute, values.

for a station into which he was not born and, in after life, a remunerative field in that station. The inevitable result is disillusion and discontent : the source of half the social unrest in this and most advancing countries.

I think we have now reached a stage in the argument which will enable us to provide a truer view of educational aim. It is that the main, and major, educational object should be to provide an education which will leave the individual a useful citizen in the sphere in which he was born. The educational ideal, contained in the above, is to inculcate in each individual that habit which is briefly and succintly given in the catechismal saying : "to learn and labour truly to get my own living and to do my duty in that stage of life into which it shall please God to call me.* It may be argued that that attitude is incompatible with ambition, the desire to ascend, but I think not. That desire may exist alongside the ready acceptance of the fact of failure. But while I insist that this ideal should form the main object of educational policy, I am equally certain that the object will only be completed by the provision of what has been termed a ladder, but a ladder so hedged about that only those suitably-equipped may ascend.

If the arguments adduced are sound, it follows that in any country the type of education most commonly found, should be adapted to fit individuals for the occupation most commonly practised, and it is only necessary to glance at the figures to appreciate how far education in this country is from the ideal I have outlined.

In the United Provinces "two-thirds of the population are supported by Agriculture, and there is no single occupation which supports one-tenth of this number of the people." In actual figures these are divisible into the following main classes:—

Zemindars, non-cultivating	500,000
,, cultivating	3,000,000
Tenants with some occupancy rights ...	10,500,000
,, ,, no occupancy rights ...	10,250,000
Sub-Tenants	2,000,000
Labourers	4,500,000
Total ...	30,750,000

While the latter two roughly constitute a class whose standard of living is such that the children have to begin to take a share in the family labours at a very early age, and for whom, therefore, the simplest primary education is all that can be provided, a very large proportion of the remainder occupy a position, such that the children are not compelled to earn a livelihood till the age of 17 or even later, and for whom it is desirable, both on individual and communistic grounds, to provide an education, fulfilling the conditions I have laid down. I have said on individual and communistic

* "To do your work honestly, to die when your time comes and go hence with as clean a breast as may be—may these be all yours and ours by God's will. Let us be content with our status, telling the truth as far as may be, filling not a very lofty, but a manly and honourable part."

In turning over the pages of Thackeray's "Essays and Reviews" during an idle half hour, I have, since this article went to the Press, chanced to light on the passage above quoted. It is one which would be hard to equal as a definition of the educational ideal.

grounds—individual, because the world's progressing is affecting agriculture equally with other occupations, and that man will succeed best who most clearly appreciates this progress and most quickly profits by new markets opened to him; communistic, because sound development of a community is only obtained by equality in the rate of educational progress of its several component parts, the unsoundest form of development being that where a small minority progresses, while the bulk of the population stagnates.

There is thus a large community, probably larger than any other single community of the Province, in a position to benefit by a suitable form of agricultural education. This state may be compared with the educational facilities provided, and in doing so, care must be taken to distinguish between teaching agriculture, and education fitting the student to return to the land. The point need hardly be laboured ; the literary nature of the mass of the secondary education, unfitting the student for practical work of any nature ; the location of the schools in urban surroundings, accustoming the student to a social life he cannot obtain at his home, and replacing the healthy outdoor life of the individual by the artificial sports of the playground—of which, though a true admirer, I recognise the limitations which include a dependence on companions for the supply of his physical recreations—are too well-known to require further development. It is true attempts have been made to introduce agriculture into the school curriculum. These, however, come to grief from failure to distinguish between teaching agriculture and supplying an education suiting the pupil to return to the land. It is not to realise that the student truly from an agricultural stock knows a great deal about practical agriculture, usually a good deal more than the master provided under such conditions to teach it, and such attempts as have been made hitherto to rectify the educational deficiencies indicated, have failed from this cause.

On the first line of my argument, therefore, we have arrived at the conclusion that the present educational system totally fails to satisfy the needs of the largest single element, if not the major portion, of the community. It is true there is an Agricultural College, but that is a coping stone without the underlying structure. Moreover, the position of a College will be more clearly understood when the second line of argument, has been developed.

Educational effort, like every form of endeavour, is limited by financial considerations. The necessary funds are obtained in a variety of ways. In many cases, as in the older Universities and Public Schools of England, the funds arise from endowments, a system well illustrated by the munificent gifts which have been made for education in the United States. In others, of which the primary educational institutions of England and a large proportion of those of this country are examples, the funds are provided by Government. In the former case the trustees are the sole arbiters in any questions as to the disposal of the available funds, and the primary consideration is the degree to which the founders' terms are complied with. In these cases, there is no question of a financial return, the trust is complete with the fulfilment of the conditions imposed. Where, however, the funds are provided by Government the position is different. Government is merely in the position of trustee for the country, and it is its duty to see that the country receives the fullest measure of return for the expenditure involved.

It is no part of my argument to justify the expenditure of public funds on education, that is generally admitted ; my concern is with the measure of the return received, with relative, rather than with absolute, values. There can be little doubt of the relative value of the two classes of education ; that which, on the average, fits a man for full development in that station in which he lives and has his being, and that which compels him to seek among fresh fields and pastures new to him, his means of livelihood. The former is a process of gradual evolution of the individual which allows for development owing to the gradual interaction between the individual and his surroundings; the latter partakes of the nature of thrusting hot glass into cold water, a process ending usually in the destruction of the glass vessel.

The true error in the educational system of this country, as I conceive it, lies in the fact that it has hitherto developed along lines which render it unsuited for the largest single element, if not for the major portion, of the population. This is no complaint that the educational facilities are excessive, but it is a very definite statement that the fullest measure is not being obtained for the funds expended. This is not merely based on negative considerations implying merely a waste of funds, such would be the case, if the schools and colleges were filled by the sons of the clerical learned professions; it implies more than this, the expenditure of funds on directions actively harmful; for, by failing to provide an education fitting the son of the landholder to remain on the land, the system drives such persons into a line of life for which they are unfitted, and in entering which they become as the hot glass to cold water. What is needed, and urgently needed, is the development of a form of education which will leave the average country youth fitted for life in the surroundings in which he is born ; there is ample scope in such surroundings for the educated mind to find full and useful employment and to fulfil the *rôle* of a useful citizen which we have laid down to be one of the main functions of education.

It is open to argument that I am here labouring to prove a point, the importance of which is already sufficiently recognised. In part that is true; the recent conferences on agricultural education, the first held two years ago at Pusa, and the second last year at Simla, indicate this. The "memorandum showing what has been or is being done to impart agricultural education to the sons of cultivators," published in connection with the report of the last conference, however, shows that a relatively small amount of effort has been devoted to this aspect of education. Nor is my main object to supply this proof. I am tempted to think the difficulty has lain not so much in the recognition of the fact as in the recognition of what constitutes a suitable form of education. The arguments, I have hitherto adduced, may incidentally prove this point, but that proof is only incidental Their main advantage lies in the fact that they provide a point of view which will, I think, help to point a way to a solution of some at least of the practical difficulties involved.

I have tried to show that, at least where the funds are provided from public sources, there is a very definite financial limitation to the method of disposal. This will become clearer on considering a concrete case. The Cawnpore Agricultural College has a four-year diploma course limited to

25 students per year, or a total of 100 students in residence. The college budget is Rs. 43,600, but this is clearly an under-charge, as it excludes all charges on the botanical and chemical sides, which are budgetted jointly with research, and it is merely the recurring charge without allowance for interest on capital charges or depreciation on building accounts. It is probable a figure of three-fourths-of-a-lakh is not an over-estimate—that is, a cost of Rs. 750 per annum per student. The question is, under what circumstances is the expenditure of this sum of public money justified? It is always difficult to argue with any degree of conviction as to the justification of expenditure where the return is as in this case, indirect. The subject is, therefore, best approached from a different aspect, and there are two such: The first is to discover the circumstances under which that return will be a maximum; and the second to consider the class of applicant now seeking admission.

The justification of the Agricultural Department must be found, in like manner, in the improvement of the economic conditions of the country, and, no doubt, the expenditure of the college is justified to some extent by the necessity of training members for that Department. That, however, is a minor matter, two only, out of the 25 students annually admitted, being admitted to the Service. Were that the only object of the college, it would appear possible to find a more economical method of recruitment. The truth is that the ultimate justification must be found in the future career of the 23 remaining students.

Now, considered in a relative aspect, it cannot be doubted that a single zemindar, possessor of several villages, who takes a personal interest in his estate and who is progressive, by reason of a liberal education such as the college is now in a position to give, is potentially a far greater asset to the country than the small zemindar or tenant cultivating a few *bighas*. In the former case the gain is not limited to the actual money value of the better crops produced, and of the extra gain due to better business methods, great though this may be. His property forms a practical demonstration which must have some influence on the surrounding countryside, and he himself becomes an unpaid propagandist of new methods. The latter, on the contrary, can do little more than grow better and more valuable crops, and he possesses little of that which we may briefly sum up as influence. The college will be filling its function to the full, therefore, only when the main source of recruitment is the zemindar class, a class relatively small, perhaps, but numerically large and potentially powerful. It can hardly be doubted that a college with students so recruited would be in a position to do more to improve agriculture and the economic conditions of the countryside, on which that improvement so largely depends, than one with students recruited from any other source. It is the condition in which the college will most fully justify its existence.

That, at least, is the aim I have set before myself, since I have been in charge of the College at Cawnpore. It is, for many reasons, an aim not immediately reliable. The larger landholders are mostly non-resident and have more immediate interest. The smaller ones are shy and frequently

insufficiently educated. For the present it is sufficient if a few only of this class come, and it is a hopeful sign that this is the case.

The majority of applicants at the present time are, nevertheless, men merely seeking Government appointments intermixed with true agriculturists, petty zemindars or tenants. Frequently the application is accompanied by an appeal for a stipend. With the former I have no concern, they are not the type of student for whom there is any opening. The latter, however, form the class to which the Department looks for its recruits and the admission of a few is justified on this ground. The claim for a stipend is a different matter, and as it is here that the financial aspect receives its clearest demonstration, a short digression will not be amiss.

To any one who has had to deal with the selection of students for admission to a college, the frequency with which poverty, as a ground for admission accompanied by financial assistance, is advanced, will be well-known. The fallacy of such a claim has, as far I am aware, never been shown up; it is certainly not generally recognised. What applies for one, applies for all. Were poverty to constitute in one case a claim to admission to a college with a stipend, every youth of suitable age would be justified in demanding this concession, and the collegiate education would become the standard, the State is called upon to provide. The cost, placed at Rs. 750 per annum in the case of the college, to the State is clearly prohibitive, and those persons who advance such a claim forget that the money to provide the education and stipends ultimately comes from their own pockets. The fact is that stipends are only justified in cases where poverty appears as a check to an ability, to the possessor of which a college course will open a useful and profitable career.

I have now attempted to define, by reference to the Cawnpore College, the legitimate function of such an institution. That function is, to a certain extent, based on local conditions, and is not therefore, necessarily identical with that of other colleges. The same financial consideration, however, underlies all, and the college aspect can never do more than touch on the fringe of the problem, reaching as it does only the numerically smallest class of persons connected with the land. If the true function is performed, however, the college will be the means of providing, in the departmental district officers and in the progressive zemindar, two agencies of effective agricultural development. The speed of introduction of improved methods is, however, a reciprocal process dependent not only on the skill and energy of the instructor, but on the receptivity of the instructed. While, therefore, the college is providing for the former, the latter is in no way provided for. The form of education provided is too expensive for the mass, it is moreover collegiate.* What is here required is a cheap form of secondary education, complete in itself and complete within the limits provided by the age at which the average boy leaves school. In the United Provinces, the sole attempt hitherto to provide an education of this type is in the vernacular two-year course of the college. The institution of this course and its location at the college is admittedly a temporary arrangement and the course suffers

* Or should be. Owing to the weakness of the secondary education, the teaching has to make up the deficiency and is largely secondary in character.

from many disadvantages. In the first place, the age of admission is too high for a true secondary school, being the same as for the four-year diploma, or collegiate, course. Secondly, in addition to supplying a course of instruction suited for the class which we are now considering, it attempts to meet the needs of the members of that class which I have shown the college should attract, but those members who possess insufficient knowledge of English to take that course, two aims which are incompatible. While, therefore, the course has not been without its uses, it fails in several directions to meet the needs of the situations. In other Provinces greatest progress in attempts to solve the problem has, perhaps, been made in the Bombay Presidency where several vernacular agricultural schools are in existence. The cost of each pupil is stated to be Rs. 180 per annum, grounds which alone would place it beyond consideration for universal adoption.† The main problem, the provision of schools supplying an education fitted to the needs of the mass of the agricultural population and at a cost which makes possible their establishment in numbers sufficient for the accommodation of the available pupils, still awaits solution.

The primary object of such schools will be to raise the receptivity of the younger generation of agriculturists and the method of attainment must be through education under conditions which retain the association with the land. This is a very different proposition to the provision of vocational schools, of which the main function is to impart technical skill. In the latter, technical instruction is the primary consideration, and theory is only taught in so far as it bears on the particular trade. In the former it is true, subjects being on the vocation may, and do, form part of the course, but the centre of gravity of the instruction is shifted. These subjects are taught for their internal value as a means of education, and the practical application is left to be drawn by a process of natural imbibition in the daily life. It is here, as I think, that the efforts, which have been made to introduce agriculture into the existing schools, have failed.

Let us consider for a moment how an agricultural school of this type would be organized. The courses of instruction are to be educational and the students are to be introduced to an appreciation of a standard of country life, something superior to the ordinary village life that, I have known, by a process of familiarity. Although, therefore, not directly a part of the education, the conditions and their arrangement will form as, if not a more important section of the school organization than the purely educational section, in that they will form an essential of all such institutions, while modification to suit the different grades will be made in the educational courses.

I will try and bring out the main features of such an organization by a description of such a school as I conceive it. It is to offer a practical demonstration of village life under improved conditions, under which the student will live and have his being with a degree of intimacy that will render those conditions a normal part of his existence. Now the essence of village life is the family, living as a unit cultivating a certain area—greater or

† A boarding secondary school of the present type costs approximately Rs. 60 per annum for each pupil.

less according, in part, to the circumstances of the family, but, in part, also, according to the locality. Thus the holdings in the East are, on the average, much smaller than those in the West of the Provinces, and allowance will have to be made for such divergencies. The school will now represent a village, the unit of communal life, composed of families, the unit of private life. Assuming a middle school with a five-year course and the maximum age 17 or 18, the students of the senior class will each represent the heads of the families which will be made up of, roughly, one student from each year, giving in all five members to each family. The school will have approximately sufficient land to provide for each "family" of five students an area, roughly, equal to the average holding of the locality. In this community the headmaster and his assistants will play the *rôle* of the zemindar and his agents. He will apportion the farm lands among the "families," issuing yearly leases at reasonable rents, and the "family" will then cultivate the land under his directions, actually performing the operations themselves. The next year a re-arrangement of students in the "family" necessitated by the head leaving and by the introduction of new admissions, combined with a re-distribution of leases, will give ample opportunity for arranging that each student will obtain practical experience, during his period of residence of each of the crops cultivated.

Before passing to the strictly educational aspect of the course, we may consider this proposal in some further detail. I have said the headmaster will play the *rôle* of zemindar; he will, if the scheme is to attain its full development, have to play many parts. As zemindar, I have stated, he will issue leases at reasonable rents. It is not proposed that those rents should necessarily be paid. The headmaster should also organize the school as a co-operative society, of which the individual heads of families are members and from which the rent can be advanced. Reality can be given by the payment of a nominal sum by each "head" for membership, but the rent and most other transactions, being dues to the headmaster, may be book entries merely. Produce would be similarly pooled for disposal on co-operative principles and may even be used to supply a co-operative store to supply the necessaries of life of the students. If payment be actually made by each student or by each "head," a nominal bonus may be given, otherwise the transactions will, throughout, be nominal as regards cash values, but in all respects should conform with reality. Thus, the amount shown to the credit of a "family" for produce received should be based on the actual sum for which the produce was disposed.

The above constitutes what I may term the environmental aspect of the school; the educational aspect may now be considered. This is an aspect which, more than any other, suffers from the danger of dogma, and, in the present case, it in no way differs from the general problem as it appears in all educational institutions. It is a problem to which each individual will offer a different solution depending on his particular personal bent. Such solution as I shall offer is, therefore, of necessity so coloured. Education as found in this country fails in two directions—the first, practicality; the

second, accuracy. With the former I have already dealt; the whole organisation of the environment is aimed at developing this character. The latter must be developed in the class-room. For this purpose the following subjects seem best fitted: mathematics, associated with which may be book-keeping and accounts, and elementary physics. With these subjects emphasized, the remainder of the course will be composed of those subjects which form the basis of the curriculum of the ordinary school, preference being given to subjects which have some association with the life the students lead. Care, however, must be taken to teach each as a balanced subject without undue prominence given to their supposed practical aspects. Among such subjects, I should place English, geography, physiography and elementary studies of plant life. In the above course—and it is not desirable to go into greater detail at present—my main object being to develop principles rather than detailed schemes, the only direct point of contact between the environmental and educational sides of the school lies in the accounts, for which the books of the institution may well be used to provide practical examples. A comparsion of this outline with, for instance, the curriculum of the Loni School, will bring into prominence the difference I have tried to emphasize.

A pupil taking five years to pass through such a course would thus gradually imbibe the practical aspect of agriculture; would be gradually introduced to those conditions which tend to place the cultivator in a position of sturdy independence and self-reliance, and should, by the end of his school career, be fitted to return to his home and the reality of life with a sense educated to realise the more backward conditions and a will to remedy them—a condition of mind and body suggestive of a career as a useful citizen. The information will, moreover, be learnt by a process of absorption from constant association, one of the essential conditions if the soundness of my contention is admitted.

There remains the question of cost, the question whether the scheme will satisfy the second or financial consideration, which it must do if it is to justify the expenditure of public funds involved. With 30 students in each class, a school of 150 will be formed for which an area of 150 acres' cultivation will be required if each holding is calculated at 5 acres. As most of the labour will be provided by the students, the labour bill will be small and the profit on cost of production should be considerable. In addition, there will be the capital charges and the cost of instructional staff. The former will be larger, but the latter not necessarily greater than the same charges of a school of the same standing but of the usual type. The unknown factors at the present stage are too numerous to make it possible to draw up a balance sheet which would approach any degree of probability to the actual, but it seems more than probable that the cost would be, on the balance, low. One point at any rate is clear; unless the farm is working at a profit, and a handsome profit, it will not be fulfilling its function, and we have here, therefore, a very simple and practical test.

One point remains to be considered, and it arises from what I have said early in this article, in bringing out the difference between the coach and the teacher. However good the system is, it will never succeed in producing

the desired result unless the agent, in this case the teacher, is competent to develop its potentialities. The aspect requires no enlargement, as its essential nature appears to be fully recognised and formed the subject of much discussion at the Simla Conference. For the present purpose it is sufficient to point out that the supply must be derived from the Agricultural College and forms a third legitimate field, additional to the two already described, of activity for the college.

The proposals outlined above constitute a scheme for providing for the educational needs of the largest section of the community, and, as far as considered, suffices for the main educational function, to fit the average youth for a useful and contented life in the conditions under which he was born. There remains the second aspect, without which no educational system can be considered complete, that of providing a ladder by which those intellectually qualified can arise. If such a ladder is to be provided, it follows that a system of secondary schools leading to the University or to the Agricultural College must be introduced. On this subject, the Simla Conference showed considerable diversity of opinion, and the probability is that the exact direction in which this will develop cannot be forecasted with any degree of certainty, and will depend on the exact form of school that is found to succeed. I will content myself with noting a single point. The type of school I have outlined contemplates the performance of the field-work by the pupils each holding and possessing a body of pupil labourers of decreasing age. If such a scheme is to succeed, and the practical work is to be carried out with that efficiency which will alone ensure success, the oldest pupils must have attained a physical development enabling them to do the more arduous field labour. That consideration would seem to indicate that greatest efficiency will be developed in those schools where the age-limit is relatively high, and hence that the type is best adapted to schools of the secondary class. The absence of the necessary physical power in the students of the Loni School was one of the points that struck me most forcibly in the one visit, I was privileged to make to that school. It would appear possible that schools of this type would lead directly to the college, and that the ladder we desire would be provided in this manner. The truth is that the practical difficulties, not the least of which is the absence of teachers, are such that the development of such schools must be slow and will afford ample opportunity for gaining practical experience. It is not desirable, therefore, at the present time to enter in too great detail into such matters. It is essentially a case for trial and experiment, the establishment of a few schools of the type described and their gradual extension in that direction which experience shows to be most desirable. What is essential is a clear comprehension of the fundamental principles which underlie the problem—a comprehension so sharp that it can be used as a test during each stage in the experiment. To the best of my ability I have attempted to supply the materials for such a test.—AGRIC. JOUR. OF INDIA. Vol. xiv, Part I.

AGRICULTURAL SHOWS.

MATALE SOUTH & EAST.

The MATALE (SOUTH) Show, first of the three shows to be held under the auspices of the Matale Food Production Society, was held at the Borron Memorial Hall on Saturday, February 8, 1919, and was opened at 2-30 p. m., by the Assistant Government Agent, who addressed the headmen and villagers at great length, impressing on them the necessity of raising more foodstuffs.

ARRANGEMENT AND EXHIBITS.

The exhibits were arranged in seven groups—each group being for the exhibits of one Korale, competition being thus limited to within that particular Korale. This was an excellent arrangement, considering that conditions are different in the respective Seven Korales. This arrangement ought to be commended for the reason that exhibitors are satisfied that the exhibits are grown or produced in their Korale and are not brought from outside.

Exhibits were few in number, but on the whole were of a fairly high standard. General collections of vegetables, from the exhibitors' own gardens, were very good. Four of these collections were particularly good. Of other vegetables, brinjals showed best. Two of the tomato exhibits were very good. Bandakka, wattakka, puhul and labu were on the whole poor. Curry plantains not up to expectations both from the point of number and standard. Yams were generally good. Mr. HAROLD MELDER's collection as well as that of a villager of Tenne would have competed well in any show.

Currystuffs.—Chillies were good. There were three collections of currystuffs, one being very good. Onions and anise were poor; ginger and turmeric: disappointing.

Grains and Pulses.—There were a few exhibits of rice and paddy, but of good order. Indian corn and Sorghum though few, good. Kurakkan, extremely poor. There was only one exhibit of green gram.

Considering that there was the severe fever epidemic late last year and bad weather during January, the show was on the whole a success.

The MATALE (EAST) Show was held at Rattota Gansabhawa on Saturday, February 15th. This was the second of the series. The Assistant Government Agent opened the Show at 2-30 p.m., before a large gathering of headmen and villagers and made a lengthy and interesting speech, in the course of which he advised everybody to cultivate more foodstuffs. The arrangements were the same as at Matale (South) Show—competition being limited to Matale (East) Ratemahatmeya's Division.

The exhibits of rice, paddy, Indian corn, wattakka, puhul and curry plantains were more numerous than at Matale (South) and of better quality. Curry plantains were particularly good. Vegetables and yams were poor. There were two specially fine exhibits of garden and field dhall and several good exhibits of chillies. Cucumbers were also numerous and good. There were several exhibits of mustard, only one of onions. Ginger and turmeric were poor. Kurakkan and other chena grains very disappointing, considering that this is a chena district.

The show was well attended and on the whole it was a success.

W. MOLEGODE, S.A.I.

APICULTURE.

HOW LARGE A HIVE?

Referring to hive sizes, as mentioned in the Editorial on "Bigger Hives and Colonies," in SEPTEMBER GLEANINGS, keep clearly in mind that it is brood-chamber capacity that is the real point at issue. With the present supering system there is ample opportunity to expand or contract the storage room, therefore, so far as hive capacity, brood and surplus combined, is concerned, every modern hive is elastic. Not so with the "long idea" hives. They must at the beginning be made to meet the needs of the "locality." Their merits and demerits we will leave to their friends. Capacity of brood-nests is affected by shape as well as size and greatly by comb quality. Do not forget this. Shape and proportions of length, to width and depth, have been threshed over most thoroughly. Deep hives, shallow hives, and wide hives all have their advocates. There are two points of view as to brood-chambers: one that of the man who wants more or less frequently to expand or contract them, which he does by giving or removing extra chambers; and that of the man who wants something which is right all of the time.

It may be asked why this matter of hive sizes has arisen now? Because our queens have outgrown our present hives. I think it is quite evident that the run of Italian queens today is considerably more prolific than were the queens of 20 to 30 years ago. But be this as it may, there is certainly an increase in the practice of expanding brood-nest capacity, either by giving two bodies or by giving the queen access to a super, both of which practices have drawbacks. Both increase the capital necessary, both double the number of frames to be handled, and the super plan introduces that vexation, two sizes of brood-frames.

An alternative is to use larger brood-chambers, either wider or deeper. To use wider makes useless all present supers, excluders, escape boards, floors, and covers. Even that quarter-inch added to the width in the last few years has been a costly nuisance. To make deeper only demands new brood-frames, for hive bodies may be pierced down quite readily.

There is little in the way of hives which I have not tried as to shape, size and protection. For a long time the Quinby (or Jumbo) seemed much too big for our moderate floors, but in recent years a careful comparison of results with it and with L's in the same teritory has caused me to change to the Jumbo entirely, the L's being used for extracting supers. I have stuck to the standard, 16-inch width and use nine frames in a "10-frame" hive with a 1½-inch spacing and as ⅜-inch offset of the outer combs from the hive sides. The offset is very valuable.—A. C. MILLER IN "GLEANINGS IN BEE CULTURE," Dec., 1918.

BEEKEEPING IN BRITISH GUIANA.

P. M. DE WEEVER.

Eciton burchelli, West or (Yakman Ant) is the most important enemy of the honey-bee in British Guiana. For days preceding an attack, the ants gather in swarms near the hive, and when the time comes, swarm up the legs of the stand, and by sheer force of numbers overpower and kill the bees Beekeepers may prevent an attack by lighting a fire to windward of a hive and feeding it with green grass and leaves. The dense smoke causes the ants to drop to the ground where they may be killed by surrounding them with a ring of fire. The surviving bees that have remained clustered round their queen should then be placed in a fresh box and fed with syrup.

CO-OPERATION.

MINUWANGODA CO-OPERATIVE CREDIT SOCIETY.

The Minuwangoda Co-operative Credit Society is one of the pioneer societies in the Colombo District in the Western Province. It was started in the year 1913 and was duly registered under the Co-operative Credit Societies Ordinance. Its founder, Mr. C. H. A. SAMARAKKODY, Mudaliyar of Alut Kuru Korale (North) has taken a keen interest in the work of the Society from the very inception and has been elected its president year after year. The Mudaliyar is the president of three other societies since established, and there is reason to believe that some more societies will in the near future be started in the division as the members come to understand the principles of co-operation.

Alut Kuru Korale is an agricultural district and the villagers are interested in the cultivation of paddy and coconuts. There are extensive coconut plantations in the Korale, and the area under paddy is also considerably large. Since the establishment of the society, the members have begun to take an interest in the cultivation of vegetables and many vegetable gardens have come into existence as a result.

The most striking progress that the society has made is in the direction of the distribution of manures. The society distributes yearly a large quantity of manures for paddy, coconuts and vegetables. The use of artificial manures for vegetables is a recent innovation, and a number of members have taken the opportunity to use artificial manure in the vegetable gardens with satisfactory results. About 20 tons of bone manure are yearly distributed to members for paddy and coconuts.

The society has at present 430 members and a paid-up capital of Rs. 2424·00. All the nett profits of the society have been set apart as a Reserve Fund amounting to Rs. 792·00.

It is situated in a very populous district, and it is hoped that in time to come all villagers will be counted among members of the society. Lately a scheme to award a scholarship to a boy of school-going age of a member of the society for four years at the Minuwangoda Anglo-Vernacular Government School has been adopted with the sanction of the Registrar of Co-operative Credit Societies. This, it is expected, will prove an additional inducement for the villagers to join the society.

The society is having a strong Committee with MR. D.M.P R. SENANAYAKE Member Local Board, Minuwangoda, as Secretary and he ungrudgingly devotes a considerable portion of his time for the furtherance of the work of the society.

N. W.

GENERAL.

GOVERNMENT TRACTOR CULTIVATION IN ENGLAND AND WALES.

Capt. G. T. HUTCHINSON:

(Mechanical Cultivations Commissioner, Food Production Department).

In order to appreciate properly the part played in British agriculture to-day by the tractor, and its possibilities in the future, it is essential to consider briefly the history of the tractors operated by the Food Production Department—the so-called Government Tractor Scheme. Without this information, misleading conclusions might be formed, and full value could not be obtained from the lessons taught by the Government Tractor.

INAUGURATION OF THE SCHEME.

The scheme was instituted at a moment when, in consequence of submarine warfare, it became necessary to grow as much corn as possible, and to grow it against time, in the British Isles. To carry this policy into effect throughout the country, some increased and more rapid means of cultivation than those hitherto in practice were demanded. Even if sufficient horses had been available their work was too slow for the emergency; further, every team of horses required a man, and sufficient men could not be found. Nor could increased steam tackle meet the difficulty, for additional sets could not be procured quickly, and corn could be grown in many parts of the country where the geographical conditions made the use of steam tackle impossible. The Government, therefore, resorted to the tractor, which could operate in Districts where steam tackle could not, and which required less labour and covered more ground than horses.

THE SCHEME ITSELF.

In these circumstances, little use could be made of the experience gained with the few privately-owned tractors in the country. It was considered necessary to purchase tractors of all types, wherever they could be found, to set them to work at once, and to deal with the question of suitable types and the renewal of worn parts as soon as the situation should permit. A beginning was made late in the spring of 1917, and the scheme was rapidly developed. In order to utilise the tractors to the fullest extent possible, some system of centralised control had to be improvised, and at the same time local arrangements had to be made for working them, and keeping them in repair. These facilities were supplied by the mechanics and repairing shops of the motor trade, which was, in effect, entrusted with the local management, under the control of the Food Production Department. Tractors were received by each county as they became available; the Tractor Representative for the county, acting in concert with the Agricultural Executive Committee, arranged their work; they were manned mainly by soldiers from the Agricultural Companies; and they were kept running by the proprietors of the provincial motor garages.

Their task was to plough land at all costs, and the initial difficulty was to overcome the reluctance of the farmer to employ an untried and suspected means of cultivation. They could not wait for suitable weather or suitable land; the position was like that of a new business, where orders must be convassed for, unremunerative contracts accepted, and a supply created, in the hope that it will create a demand. Such was the preparation by the Government tractors for the 1918 harvest. After the completion of the spring cultivation, it became possible to place the scheme upon a more workable basis. At one time, more than 20 types of tractors were employed by the Government, and the inconvenience and frequent impossibility of providing spare parts and repairs for each type constituted a serious handicap. Within the past few months it has been possible to reduce the types to six, and to ensure the supply of spare parts, so far as war conditions permit. It has also been possible to decentralise the scheme, and to hand over to each County Committee the control of the tractors allotted to it. In several counties a further advance has been made by loaning the tractors to individual firms to operate as a private enterprise, subject to such control as the County Committees consider necessary. Experience has shown that with tractor ploughing, as with other forms of business, better results are obtained by private enterprise than by Government employees. It has also been possible to release tractors for sale to individual farmers, and since the beginning of this year some 3,000 to 4,000 tractors have been disposed of in this way.

RESULTS OF THE SCHEME.

To summarise briefly the results of the scheme, it may be said that it has fulfilled its object. It enabled County Committees in every instance to carry out their programmes for increased corn production; it assisted them to reap their harvest; and it has introduced a new and highly efficacious means of cultivation to the farmers.

To form a proper estimate of the capabilities of this instrument, however, a careful distinction must be drawn between the tractor of the Government scheme and the tractor in the hands of the farmer. The former was employed as an emergency measure; in consequence its work was often imperfect, labour was wasted in connection with it, and operating expenses were high. In the hands of the farmer, on the other hand, the tractor economises labour and does the work cheaply. It would be most unfortunate if agriculturists should be tempted to base their opinion of the merits of the tractor solely on their experience of the tractor scheme.

DIFFERENCE BETWEEN THE GOVERNMENT AND PRIVATE TRACTORS.

The points of difference may be conveniently grouped under five headings:—

(1). *Working Expenses.*—The first of these points concerns working expenses. The exigencies of the situation required that the Government tractors should be available wherever they were required. They were, therefore, grouped in units of (in most cases) ten tractors, each unit serving a wide district. Steam tackle working under similar conditions would move from farm to farm as a self-sufficient unit, complete with plough, cultivator, and cabin for the crew; the farmer would have fuel and water ready in the

field. The tractor, however, cannot haul its own fuel supply, and, under war conditions, the farmer cannot provide it. Petrol, paraffin, and grease must be delivered daily in a light motor-van : this method is expensive, but delivery by horse transport would be too slow, and a motor-lorry could not reach the inaccessible fields in which so many of the tractors are employed.

In cases of mechanical trouble, a mechanic must be summoned from the headquarters of the unit to effect the necessary repairs. From time to time a supervisor of some sort must also visit the tractor, to see that the men are working, and that the ploughing is satisfactory. With the privately-owned tractor these officials disappear; the farmer keeps the fuel in his coach-house, supervises the work himself, and avoids the necessity of frequent repairs by taking care of his tractor. If bad weather stops the work, he can find another job for the driver, but the drivers for the 4,000 Government tractors, scattered in billets all over the various counties, often spend an idle day.

(2). *Repairs.*—The second point to be considered is the question of repairs. Most of the tractors operated by the Government were built in America, where paraffin as a fuel is little used. The engine is designed to burn petrol or petrol substitutes, which are drawn off from the crude oil because of their volatility. Paraffin is a by-product of these oils and is not actually a volatile fuel oil. It has to be made so by means of an atomiser and superheaters, before being introduced into the combustion chamber. Time and experience are now meeting the difficulty, but last spring the work of the Food Production Department could not be delayed. Petrol could not be spared, but paraffin was available. Tractors were hastily adapted and worked with paraffin, and in some cases this has resulted in excessive wear of engine parts and consequent engine trouble. Competent mechanics have not always been obtainable when required, and the supply of spare parts, in war time, in sufficient numbers for the Government tractors, has been a perpetual difficulty. The critic who concludes that the tractor is no good, because he has seen one standing idle for weeks in the field, should enquire whether it is in fact waiting for a spare part which lies at the bottom of the Atlantic ! The peace-time tractor will not suffer from this handicap.

(3). *Nature of the Work.*—A third point to consider is the difference in the nature of the work which the Government tractor and the farmer's tractor are required to perform. For various causes, which it is unnecessary to discuss here, in nearly every part of England some very unsuitable grass land has been ploughed up within the past twelve months, and the most unsuitable has usually been allotted to the Government tractors. Much of this work has not been ploughing, but reclamation. The Government tractors carried out some astonishing performances last spring. They dug themselves deep into the Midland clay, they broke implements innumerable on the concealed rocks and boulders of the west country, and they skidded vainly about the hillsides of Wales and the North. Fatal accidents were not unknown, but land was ploughed—at a cost—and crops were grown : it was "magnificent, but not agriculture." No doubt this reclamation work has already justified itself, and the average farmer will not purchase a tractor to reclaim land, but to plough.

Government tractors were also operated in typical grass counties in the Midlands and in the West, where each farmer had sacrificed one field to the

good cause. Here the fields themselves might be suitable, but the amount of roadwork involved in going from farm to farm, with consequent high fuel consumption and wear-and-tear to the tractor, made economic working impossible. This difficulty will not apply to the farmer's tractor.

(4.) *Labour.*—A fourth point of difference is labour. At the end of the spring cultivations in 1917, the Food Production Department was operating about 600 tractors; at the same period in 1918 it had over 4,000. Drivers had to be found and trained from such material as the exigencies of war left at the disposal of the Department. When the Government tractors are disposed of, these men will be available for the farmers, and already measures are being taken to assist the training of drivers for privately-owned tractors. The farmer will at least be able to select a suitable man to train for his tractor, but the Food Production Department was never in a position to pick and choose. A most encouraging feature is the excellent results so frequently achieved by the hastily-trained Government drivers, and the satisfaction which women drivers have given in so many counties.

(5.) *The Implements Used.*—Another advantage which the farmer's tractor will have over the Government tractors is that the farmer will be able to attach it to the plough or cultivator, which is most suitable for his particular requirements, whereas the Government tractor is limited to such implements as are now available. In nearly every part of the country the experience of generations has evolved a special plough, cultivator, or harrow, to deal with local peculiarities of soil or cultivation, many of which are manufactured locally. In war-time the out-put of such implements is limited, and if all are commandeered by the Government, the demands of private purchasers cannot be met. It has, therefore, been necessary to purchase implements in bulk for use with the Government tractors, largely in America, in order to carry out Government cultivation without unduly curtailing the supply available for individual farmers. It is, however, unreasonable to expect that their work should be equally satisfactory in all localities. One type of Oliver plough made to turn a wide furrow has proved unsatisfactory on hard ground, until converted to turn a narrower furrow. In some counties a heavier cultivator than those cultivators now obtainable is demanded. In these cases it is manifestly unfair to condemn the tractor because the right cultivator's implement is not obtainable, and the work has suffered in consequence.

POSSIBILITIES OF TRACTOR CULTIVATION.

It remains to consider what profitable conclusions can be drawn from the experience of the Government Tractor Scheme as to the possibilities of tractor-cultivation in England.

In the first place it is established that to obtain the best economic results from the tractor, it should be in the hands of the farmer, and should not leave his farm, except, perhaps to assist his immediate neighbours, in cases where such an arrangement is possible. Though there is no doubt that tractor-ploughing firms will be started, to carry out work on the same lines as the existing steam-ploughing firms, the difficulties of fuel supply, roadwork, and supervision, must always place this system at a disadvantage, when compared with the privately-owned tractor.

Work Done.—Sufficient has already been said to indicate that the acreage results achieved by the Government tractor must not be accepted by prospective purchasers as a final test of their capabilities. The statement of weekly averages in the counties, circulated by the Department, shows that few counties are able to maintain an average of 10 acres ploughing per week per tractor in commission, or a fuel consumption below 5 gallons per acre. In nearly every county, however, a Fordson tractor, with a self-lift plough, has ploughed over 5 acres in the day under favourable conditions, in the hands of one reasonably competent man or woman. The same tractors have frequently cut upwards of 15 acres in the day with a binder, which would not be exceeded by two teams of three horses working in two shifts. The fuel consumption of the farmer's tractor should be in the region of three gallons per acre ploughed.

Quality of Work.—It has also been proved in every county that the quality of the work done by tractors can be perfectly satisfactory. It serves no useful purpose to compare their work with that of horses or steam tackle, because all three will be required ; it must depend on circumstances in each case which method can be, or should be, adopted. Plenty of bad work has been done by the tractors, the reasons for which have been fully explained. The best testimony in their favour is the verdict of the farmer, and whereas a year ago it was necessary to canvass for orders for work for the limited number of tractors available, to-day, in practically every county, the tractors are scarcely able to carry out the daily increasing number of contracts for ploughing.

Quick Work.—It is now realised that the tractor enables the farmer to cultivate at the right time, and the importance of this is appreciated by every practical farmer. Theoretically, if a man has the requsite "strength" for his farm, he should be able to keep it employed throughout the greater part of the year, and to carry out the successive operations of husbandry, each in its proper course. In practice, climatic conditions make this impossible. One operation is delayed by the weather and subsequent operations suffer.

The broad distinction between the bad and the good farmer is that the former is usually in arrears and the latter beforehand with his work, because he has a reserve of "strength" to meet these emergencies. The tractor provides a reserve of cultivating strength which eats nothing and costs nothing when it is not employed. For example, during the past summer many farmers were able to employ all their horses for leading their earliest corn crops, while the later ones were being cut with tractor and binder, and by this means to complete their harvest before the weather broke. The same men could then plough their stubble with the tractor while their horses were still leading the later corn crops. Their neighbours, without this additional "strength," have had corn spoilt and have afterwards had to spend idle weeks waiting to plough their sodden stubbles. There is always a certain period of the year when the soil is in the improper state for ploughing ; it is then possible to plough better and deeper, leaving the ground in good condition for subsequent cultivation, and for preparation of the seed-bed which will give the best yield. If this opportunity is lost because the normal strength of the farm is otherwise employed, it cannot easily be recovered—on heavier soils it may mean a year's delay—but with the tractor it need not

be lost. It is a notable fact that in some counties, in spite of the wet autumn, work on the farms is actually more advanced to-day than it was at this time last year—thanks to the tractor.

TYPES OF TRACTORS.

It is often asked, which is the best sort of tractor to buy? The Food Production Department have employed more than 20 different types, all of which have had their good and bad points. Six types have now been, retained, but it must be remembered that, in eliminating, the possibility of ensuring an adequate supply of spare parts for the types retained was an important consideration. Of these, the "*Titan*" has done excellent work under the most variable conditions. It has ploughed on the Devonshire hill-sides and in the holding clays of the Midlands, and it has been used as a stationary engine to thresh, to cut chaff, or work a saw. The main improvements which have been made in some cases are a better fore-carriage, and special spuds on the wheels to hold on slippery ground.

Another "general utility" tractor is the "*Overtime*," and many of these tractors have now been in the hands of private owners for upwards of a year, and have given satisfaction.

The "*Clayton Shuttleworth*" is a powerful and more expensive tractor, which has been found specially suitable on heavy clay land, as the pressure on the land is considerably reduced by a "caterpillar" track. It is the only tractor of this type now operated by the Department.

The "*Saunderson*" is another British-made tractor, which has the advantage of a winding drum, and has therefore been in request for threshing as the drum enables it to haul a threshing box up a steep pitch in a country lane. It has been found more satisfactory than other tractors for roadwork

The "*25 H-P. Mogul*" is a heavy tractor, employed mainly for threshing but in some counties it has done a lot of work with the plough, while the land was in a suitable condition. It is too heavy for use in wet land.

The "*Fordson*" tractor is probably the cheapest tractor on the market, and, if its limitations are recognised, it is the best labour-saving device which the farmer can obtain. It is the only Government tractor equipped with a self-lift plough, and can, therefore, be worked by one man. It is not yet a "general utility" tractor, as it may prove to be too light to be used effectively as a stationary engine, but for the purpose of cultivating it is an acknowledged success. It is often said that it is unsuitable for heavy land, but its success in Essex and other heavy-land counties has led its adherents to believe that, when heavy land is in the proper condition for ploughing, the Fordson can plough it, and when it is not, it is the best to leave it alone. No less than 2,500 of these tractors have already been purchased by private owners, a fact which indicates the farmer's opinion of its merits. For some time its reputation suffered because the No. 7 Oliver plough turned a 14-in. furrow, which in many cases proved unsatisfactory. This plough has now been converted to turn a 10-in. furrow, with the best results, and two other types of Oliver plough, one of them specially adapted for ley-ploughing, will shortly be on their trial in the counties. Other improvements now being carried out by the Department are the provision of a "governor" for the engine, a break for roadwork, and a "release" attached to the draw-bar, to

prevent accidents in case of the tractor rearing up. In some cases, too, it has been found necessary to alter the strakes in the wheels in order to gain a better hold on slippery ground.

HOW TO SELECT A TRACTOR.

Unquestionably the proper course for a prospective purchaser to adopt is to examine the work of his neighbour's tractor, or of the different types of Government tractors in his county, before making his selection. He should have no difficulty in obtaining full information from the officials employed by the Executive Committees of his county, and by this means he can see and judge for himself which type is best suited to his particular requirements. He should also remember that the implement is just as important as the tractor, and can form his own opinion of the former by examining the various makes now utilised by the Executive Committees. For example, the work of the disc cultivator, and of other new implements, may be inspected with advantage. It may be added that, though tractors will undoubtedly be improved, it is better policy under present circumstances to purchase one of the reliable tractors now available than to wait for a perfect type. It is vain to hope for a tractor which will be equally good for cultivation and road haulage. Presumably the motor-lorry represents the best type of internal combustion engine for roadwork, and it is impossible to imagine any form of motor-lorry which could be utilised with a plough.

If British agriculture is to derive full advantage from the experience of the Food Production Department, much can be done by the Executive Committees of the counties. These Committees have recognised that the Government tractors must work primarily for those farmers who could not cultivate under present circumstances without assistance and that applications for tractor-ploughing received from farmers, who should be in a position to cultivate for themselves, must be deferred. The latter should purchase their own tractors or more horses. It is to be hoped that the time is not far distant when all farmers will be in a position to dispense with Government cultivation. Meanwhile, Committees can place at the disposal of the farmers the experience gained with the different types of tractors and implements employed in their county.

The writer of these notes has prepared them after seeing something of the work of the Government tractors in practically every county in England and Wales, and after discussing the difficulties encountered and the results achieved, with those who have operated the tractors since the inception of the scheme. Any points which may be described as technical have been carefully verified by the experts employed by the Food Production Department. Though criticism of the tractor scheme is by no means unknown, there are no two opinions as to the value of the work of the tractors, and it only rests with the farmer to take advantage of what is probably the widest form of practical demonstration ever carried out by an Agricultural Department.—JOUR. OF THE BD. OF AGRIC., Dec. 1918.

SEED AND SEED FARMS.

J. MACKENNA, C.I.E., I.C.S.

(Agricultural Adviser to the Government of India.)

One of the most striking characters in Indian crops, grown for centuries under the same conditions is the enormous extent of admixture of varieties in almost every field and perhaps no part of the world offers a finer field for investigation to the Economic Botanist. In this country where a well-bred animal or plant is rare and soon begins to degenerate and where the evil of sowing mixed seed is so rampant, the question of production, maintenance and supply of pure seed of an improved plant is of the utmost concern. In Europe and America intelligent farmers do a lot of work in this line. Besides, these are the well known firms of Sutton, Garton, Henderson and others of high repute who are both plant-breeders and seed-suppliers, and whose names are a guarantee of reliability. In India this duty devolves on the Agricultural Department. The first work is to separate types from the prevailing mixtures and evolve an improved variety. The second stage is to introduce it into general cultivation and to maintain the quality. For this purpose seed-farms are necessary. It is most essential that a continuous flow of improved seeds should emanate from the central seed farm so as to establish the crop on a firm basis in one locality.

If the Botanist improves a plant both in respect of yield and quality and the Deputy-Director of Agriculture spreads it far afield among the cultivators in his Province, the Department can be said to have introduced a valuable improvement which costs the cultivator nothing. As a rule, capital is required with which to buy a new reaper or to purchase artificial manures, or a whole monsoon crop has sometimes to be sacrificed in order to make room for the application of green manuring ; but in the introduction of an improved variety practically no increased expenditure is required on the part of the cultivator beyond the nominal charge for the improved seed. In India the mere separation of types has led to great agricultural progress and the Departments are exploiting this line of work for all it is worth. Improvement of a crop by breeding varieties combining desirable characters from two or more varieties is a much more laborious and costly process, as has been proved by the work of the Howards at Pusa, but it is most essential that such work should be undertaken at properly-epuipped centres by officers devoting their whole attention to this work ; otherwise when the improvements based on mere selection are adopted by the cultivators the Department will have nothing further to offer by way of demonstration.

The question resolves itself into (1) how the improvement of crops is to be attempted; (2) how the quality of improved seed produced is to be maintained; and (3) what arrangements should be made for their supply to cultivators. All the work of botanists and agriculturists in the improvement of crops will be in vain if practical means for supplying pure seed and maintaining its purity are not devised and organised.

Since the foundation of the Agricultural Departments in this country in 1906, a considerable amount of attention has been paid to the improvement of the cultivated plants of the country. New crops have been introduced and better varieties of existing staples have been brought to the notice of the people, coupled often with improved methods of cultivation. The success

of these efforts has in turn raised the question of the best means of maintaining and distributing pure seed of improved varieties of crops. The subject was considered by the Board of Agriculture at its meeting held in 1911, and a special Sub-Committee under the Chairmanship of Mr. Howard was appointed to deal with it. The report of that Committee contains many useful suggestions, and I would recommend every one interested in plant-breeding work or in the work of distributing improved seed to go carefully through it.*

The general aim to be kept in view is the replacement wherever possible of the existing mixtures by pure types characterised by increased yield and by improved quality. As regards methods of obtaining improved varieties, it would be well to emphasize at the outset the necessity of basing all work in this direction on the study of the method of pollination of the various crops investigated. It is especially necessary in the case of plants which cross-fertilize that this preliminary work should be undertaken, otherwise much time and energy will be wasted in selection experiments and variety trials which cannot possibly yield any useful result. It is desirable further that this preliminary work should be conductedi n the tract concerned as several cases have been observed in which climate has considerably modified the usual pollination mechanism, e.g., it has been observed by the Howards that natural crossing in wheat is much more frequent at Lyallpur than at Pusa.

In the case of self-fertilised crops, the comparison of the progeny of single selected plants might easily result in the production of the desired improvement. In this case all that is necessary is to multiply the type and begin the work of seed distribution. In the case of plants which cross-fertilise the procedure is not so simple, and special measures are necessary to avoid the consequence of vicinism.

In introducing varieties of crops from other tracts or countries, it is necessary to study the constitution of the crop and possibly to apply methods of selection. The immediate distribution of imported seed is undesirable, owing to the possible prevalence of inferior types. Neglect of these precautions in the past probably accounts for the want of results in introducing exotic cottons into India. If the desired improvement cannot be obtained by selection, it may be necessary to cross suitable types and to evolve a new form combining the special characters desired. Work on the above lines should result in the production of a stable agricultural type which alone should form the basis of future seed distribution.

In the testing of varieties of crops which cross-fertilise, there are special difficulties to be overcome. The seed of different varieties grown side by side cannot be employed for the production of pure seed. For the same reason, variety trials should not be conducted on seed-farms unless special precautions are taken to isolate the plots from which the pure seed will be derived. As regards the maintenance of pure types, the Botanists in each Province should maintain a collection of the improved types introduced into general cultivation by the local Department. This collection will serve as a source from which pure seed can be obtained whenever it should be necessary to re-stock the seed farms.

*See *Proceedings of the Board of Agriculture in India*, 1911. Also see *Agri., Jour., India, April* 1912.

The main principles which should guide the work of the Agricultural Department in the growth and distribution of seed to cultivators in India have been laid down by the Board of Agriculture in India as follows :—

(1) The desirability of concentrating the efforts of the Department on one or two well-defined problems at a time rather than wasting its resources of indiscriminate seed-distribution.

(2) The desirability of confining the work of seed distribution in any one tract as far as possible to one sort and of systematically replacing existing mixtures by this pure type. This is particularly necessary in the case of cross-fertilised plants where degeneration through vicinism is of such great importance. The distribution of one sort has the further advantage of creating large supplies of one particular type and thus forming a trade centre for this produce and attracting buyers.

(3) The necessity of utilising to the utmost the present staff resources of the Department and of supplementing this by enlisting the assistance of leading Agriculturists in the work of seed-growing and seed-distribution in the tracts concerned.

Seed-distribution will thus naturally start from a central farm and gradually spread outwards. The assistance of the best farmers should therefore be enlisted, the seed fully charged for and the work conducted in tracts where markets already exist for the produce. Botanical control of the central seed-farms is very necessary. These should be visited by the Botanists whenever possible. Great care is required in seed-growing both as regards seed-cultivation and also as regards contamination from such sources as the seed of a previous crop, the dung of animals, irrigation water and the like.

The question of marketing the produce is of considerable importance in the work of seed-distribution and specially where distinctly improved crops are being grown. In the beginning it is not always possible for the people to get the real value of their produce and for the improvements to be fully recognised by the trade. It is most advisable to send the improved product to the best market and sell for the several years there sufficiently large consignments of the produce. In carrying out experiments of this nature, however, three points must be remembered :—

(1) That a single consignment in a large market or exchange is unlikely to attract much notice unless special attention is drawn to it.

(2) That single occasional consignments do not fetch the same price as the produce of recognised value known to be regularly obtainable in large quantities.

(3) That as in the future the marketing of the produce must be in the hands of the local buyers and agents, it is advisable where possible to enlist their help and carry on this work with their co-operation.

Having enunciated the general principles which should govern the improvement of crops, the production of seed and the best principles for preserving the purity of the seed and organising the supply, we now come to the results already obtained from such work in the Provinces. The success attained has been most gratifying, particularly in the two crops, cotton and wheat, which have been the subjects of serious study at the hands of the officers of the Department.

The distribution of improved seed of a crop like cotton (in which natural cross-fertilisation is common), in such a manner that the improvement in the staple can be maintained permanently, is a problem of the greatest interest in Agricultural Science. If this work is to be of lasting benefit to India, the present cottons in any particular tract must be entirely replaced by one kind which breeds true to type in order that results of vicinism may be prevented and the mixing of seed at the ginneries rendered impossible. During the preliminary breeding and selection operations, it is necessary to protect the flowers from foreign pollen and to work entirely with self-fertilised seed. This circumstance adds greatly to the labour involved in the work and also entails as a preliminary the isolation of pure lines from the mass of splitting forms (which make up the bulk of the cotton crop of India), before crossing can be begun.* Further, an improved type will have to be grown separately and every care taken to keep the seed supply pure and to prevent any degeneration taking place as a result of vicinism. It is now generally recognised that the degeneration which results when improved cottons are introduced into a new country is largely a result of vicinism. The exotics in the first place are often a mixture of types which cross among each other, while further degeneration results from the admixture crossing with local sorts. It is more than probable that the want of success in introducing foreign cottons into India in the past has been mainly due to natural cross-fertilisation.

MR. CLOUSTON's work in connection with *roseum* in Berar is of great interest as showing that where the improvement aimed at is only one of yield and not of quality; the system introduced by him of supplying the seed is probably the best. MR. CLOUSTON separated this type from the so-called Jari mixture generally grown by the cultivators. It may be mentioned that *roseum* is a short staple cotton characterised under ordinary conditions by high yield, high ginning percentage and robust growth, and it pays the cultivator to grow it. From the Akola farm as a centre, the system of seed-distribution has been developed by M. CLOUSTON† on the following lines :—

Leading landowners who were also members of Agricultural Associations were selected as suitable men to look after the local private seed-farms and at the beginning the Government guaranteed to these men to make up any loss resulting from the improved methods of cultivation and the growth of seed which the Agricultural Department recommended. The selected seed from the Akola farm was sold to these private seed-farms and the owners themselves arranged for its sale and distribution. The supervision of the Agricultural Department was confined to cultivation, ginning and advertising the seed in their monthly vernacular journals. The work has been considerably simplified by the formation of Agricultural Unions, the members of which grow only *roseum*. These members obtain their seed from the Union Central Farm which is supplied from the Government farm. The Unions provide small ginning plants driven by an oil-engine and for this the Government sometimes advance a loan of Rs. 2,000. The success of this line of work has been so

* See the Sections on Economic Botany in the *Annual Reports of the Board of Scientific Advice in India*, 1911-12, 1912-13, 1913-14, 1914-15.

† See *Agricultural Journal of India*, Vol. VI, pp. 361-63 ; also Vol. X, pp. 150-51.

striking that the number of seed-farms in Berar in the year 1916-17 was 513; the number of registered and unregistered Unions 51; and the amount of seed sold was sufficient to sow over 800,000 acres resulting in an added profit to the cultivators of over 120 lakhs of rupees. *, †

It would be well to point out that in the Central Provinces, the question was very simple, as it was concerned with an increase in the yield only. A certain amount of natural crossing which usually takes place is not so important here as in the case of distribution of *karunganni* in Tinnevelly, of Cambodia in South Madras or of improved Broach in Gujarat. In all these latter, quality of the fibre is the main consideration.

The problem of establishing a variety characterised by an improved staple is much more difficult than that in which a higher yield is the main feature. This will be exemplified from the work of the Madras Department in connection with Tinnevelly cotton, a lucid account of which is given in MR. SAMPSON'S article on "Recent History of the Cotton Improvement Work in Tinnevelly and Ramnad Districts" in the April (1912) issue of the AGRI. JOUR. OF INDIA.

The efforts to improve the cotton crop in the area where Tinnevelly is grown commenced in 1905, when a detailed survey of the area was begun. In the North of the tract the *uppam* variety was found to predominate; while in the South the variety *karunganni* was held in greatest esteem. There was however a good deal of admixture of these two forms all through this region. The best villages were those which preferred to hand-gin the *kapas* and to sell their lint, while the worst were those which sold all their *kapas* and depend on outsiders for their seed. At first an effort was made to distribute improved seed of both these varieties, *uppam* in the North and *karunganni* in the South, but experience showed too much was being attempted with the means available, and it was decided to restrict the work to the Southern half of the tract and to improve the *karunganni*. The operations were started at the Koilpatti farm, and in a short time seed sufficient to sow 10,000 to 12,000 acres of pure *karunganni* each year was distributed. This naturally had a considerable effect on the quality of the cotton. New ginning factories were put up by cotton-buying firms in the tract, mainly on account of the superiority of the crop. These factories combined with two or three seasons of short crop were found to have undone the work of the Department in keeping the crop pure. In the words of MR. SAMPSON: "In 1912 it was found that what a year or two previously had been practically a pure *karunganni* tract was again a hopeless mixture of bazaar seed. Although ginning factories under proper management do much to maintain the quality of export cotton by having the ginning under control, their introduction tells very seriously on the quality of the seed sold for sowing. Village dealers instead of ginning the villages *kapas* by hand and selling the lint, now disposes of the *kapas* to travelling dealers who deals directly through the brokers employed by the factory Consequently all *kapas* whether good or bad is mixed, bad samples graded up with good *kapas* which will not pass muster is similarly graded up till it does. The crops in the neighbourhood of these factories further showed that much of the seed had been brought from a distance. *Kapas* instead of being stored

* See *Agricultural Journal of India*, special Indian Science Congress No., 1917, p. 32.
† *Report on the Progress of Agriculture in India*, 1916-17 p. 24.

dry, as formerly, is now often collected straight from the field and packed immediately into *borahs*. The result is that much of the cotton heats and the vitality of the seeds is either weakened or altogether destroyed." In 1912–13 the work was therefore started afresh with improved selections obtained from the local crop and efforts were made to control the seed supply and to concentrate the improved cotton in certain villages. The new types now distributed are a great improvement on the country crop both in yield and quality. In 1916 some 56,000 acres were sown with the Departmental seed of selected Tinnies. The system of joint sales and ginning has been expanded and regular seed Unions working under rules have been formed. The aim of the Department is to spread a network of those Unions over the whole Tinny tract, so that the bulk of the seed required may be supplied by these Unions.

It will thus be seen that the chief difficulties with regard to the improvement of Indian cotton particularly where quality is concerned arise *after* a better cotton has been obtained at the experiment stations. The seed-distribution should be concentrated in a comparatively small area at first, and arrangements should be made for separate ginning. It is necessary to maintain effective supervision with a view to prevent adulteration. Official assistance in marketing the superior produce may be given at first, but later on co-operative sale by the growers themselves should be encouraged. Only when the new kind is completely established, should the Agricultural Department transfer its operations to another tract.

The difficulty met with in spreading a type of cotton of improved fibre is well exemplified in the case of Cambodia in Madras. The rapidity with which it spreads, the part the private agency had in the matter, and the fact that most of the seed supply was not controlled by the Department, points a lesson to all connected with the establishment of high quality cotton in India. To bring about any permanent improvement, it is necessary to replace systemetically all the existing cottons in a tract by one type. This replacement to be effective must be controlled by the Agricultural Department. There must always be a risk of fraudulent adulteration of seed if the seed supply is not under strict control and hence it is preferable to work in one or two Districts at a time rather than to allow the cotton to spread itself. Only in this way can the consequences of natural crossing, of mixing of seed by ginneries, and of fraudulent admixture be prevented.

In the case of wheat in which self-fertilisation is the rule, the question of seed-distribution does not present the same difficulties, as have to be overcome in the case of cotton. It is only in the irrigated tracts like the Punjab where the air is dry that natural cross-fertilisation in wheat is of sufficient importance to be considered in the work of seed-distribution. Admixture of kinds in wheat at threshing time can be to a great extent prevented by using a separate threshing floor for such kind or by the use of *pucca* floors. Even when admixture takes place, the cultures can be started afresh from a single plant and a large quantity of pure seed is very soon obtained. Further, the amount of seed per acre in wheat is relatively large so that the area of the seed-farms is not so large as in the case of cotton. The only problem in wheat distribution in India after the best wheats for any tract have been obtained is the question of grades. The establishment of such grades as those of the Canadian wheats is most necessary in order to win the confidence of

the trade and to adequately remunerate the cultivatiors. To bring this about, it will be necessary to confine the seed-distribution in the various tracts to wheats of one or two grades and to replace the existing crops by these grades.* The distribution of Pusa wheats is proceeding on these principles and already considerable areas in Behar and the Central and Eastern Circles of the United Provinces grow these wheats. In the Northern Circle of the Central Provinces, where also considerable work has been done in connection with the testing and introduction of improved varieties of wheat, MR. G. EVANS found it necessary to organise seed-farms. These are described in his article in the AGRICULTURAL JOURNAL OF INDIA, July 1913, to which reference may be made by those interested on the subject.

I think the examples I have given are sufficient to illustrate the difficulties in running the seed-farms, the principles on which they should be conducted, and the amount of good they are capable of doing in ameliorating the material condition of the cultivators. These principles have now been thoroughly grasped by the Departments and the success, which is now attending the efforts to push the cultivation of Pusa wheats over most areas of India, of American cotton in the Punjab, of selected wheats in the Northern parts of the Central Provinces, of the selected variety of rice known as Indrasail in (Bengal to name only a few) are a happy augury of the future development of the greatest industry in this country.—JOUR. OF THE MYSORE AGRIC. & EXPERIMENTAL UNION.

CASTOR OIL.

H. ROSS:

(Chief Inspector of Agriculture, New-South Wales.)

The heavy demand for castor oil, principally for lubricating purposes, that has set in during the last few years, has led farmers in various parts of the State to make inquiries regarding the possible cultivation of the castor oil plant on a commercial scale.

Indigenous to Northern Africa and India, the plant (*Ricinus communis*) has spread to all parts of the world possessing tropical and sub-tropical climates. Its introduction into Australia is due more to the fact that it has been grown here for years past as an ornamental shrub rather than as a commercial crop ; in fact, no records are available to show that the castor oil plant has at any time been cultivated in New-South Wales with a view to producing beans and extracting the oil. Perhaps there is a good reason for this when we take into consideration present labour conditions.

WHERE GROWN.

Castor beans are largely grown in India, the United States of America, Java and Brazil—England, France, Germany, and Belgium depending upon these countries for the supply of the beans.

India has, in the past, produced more of the beans than any other country in the world, and the whole of Europe practically depends upon that country for its supply. Mills for the extraction of the oil are in existence throughout Europe.

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* Howard, A. *Report of the Board of Scientific Advice in India*, 1911–12, pp. 194–95.

Quoting statistics supplied by CHARLES M. DOUGHERTY, of the Bureau of Crop Estimates, United States Department of Agriculture, it appears that India has enjoyed practically a world monopoly in this crop. Besides producing more oil than any other country, it is estimated that India exported between 3,000,000 and 5,000,000 bushels of beans annually.

As far as Australia is concerned, it appears that not much attention has been given to the importation of the beans and subsequent extraction of the oil; the oil itself is imported.

The quantities of castor seed exported from India to the principal consuming countries during the five years, for which figures are available, have been as follows *:—

Exports of Cator Seed from India to—	1904-5	1905-6	1906-7	1907-8	1908-9
	cwt.	*cwt.*	*cwt.*	*cwt.*	*cwt.*
United Kingdom ...	452,358	479,348	649,874	1,121,035	806,789
France	266,845	286,848	277,002	267,383	333,959
Belgium	275,179	185,568	198,785	289,733	207,093
Italy	252,010	197,249	166,268	237,028	176,223
Germany	193,402	136,757	203,691	70,499	109,603
Total Exports ..	1,460,908	1,298,624	1,505,059	1,993,717	1,650,466

The quantities of castor oil exported for the same period have been as follows :—

Exports of Castor Oil from India to—	1904-5	1905-6	1906-7	1907-8	1908-9
	gals.	*gals.*	*gals.*	*gals.*	*gals.*
United Kingdom ...	256,975	191,034	129,102	233,583	131,303
Ceylon ...	72,041	61,994	65,818	81,233	63,980
Straits Settlements ...	242,672	201,169	185,019	186,686	176,824
Hongkong ...	102,524	68,392	33,737	18,268	13,533
Cape Colony ...	110,344	92,070	172,802	81,495	9,069
Natal ...	212,269	255,528	231,358	215,137	73,690
Mauritius & Dependencies..	92,582	105,867	96,602	92,415	82,414
New Zealand ...	89,841	111,748	132,380	129,640	166,718
Australian Commonwealth..	428,520	293,677	363,723	439,445	352,841
†Other Foreign Countries...	14,342	45,837	21,921	23,114	23,275
Total Exports...	1,632,106	1,432,108	1,455,636	1,508,545	1,099,967

IS CASTOR BEAN PRODUCTION PAYABLE?

To answer this question it has to be borne in mind that countries in which cheap labour is available are the principal producers; therefore, the question of exporting our surplus crop is one which cannot be regarded seriously, and to satisfy the local demand must be the one aim of the would-be producer.

The following questions naturally present themselves :—

1. What is the demand for castor beans?
2. How many bushels per acre is a fair yield?
3. What is the probable price per bushel?
4. What is the cost of production, including rent of land, seed cultivation, harvesting and marketing?

The answers are :—

1. The demand is a limited one; assuming 100,000 gallons to be sufficient for New-South Wales requirements, about 3,500 acres under this crop will supply this demand.

* BULLETIN OF THE IMPERIAL INSTITUTE, 1911.
† Principally Siam, Portuguese East Africa, Japan and Dutch Guiana.

2. Not more than 20 bushels per acre can be expected, although yields of 30 and even 40 bushels per acre are recorded from Florida, South Carolina, Georgia, Texas, and California.

The Queensland Department of Agriculture, in the July issue of the QUEENSLAND AGRICULTURAL JOURNAL, states that the average yield is about 20 bushels per acre.

3. The price per bushel can hardly be estimated, in so far that no market has been established in the past for beans in Australia.

The War Department of Washington, U.S.A., has let contracts for the supply of beans at 3·50 dollars (approximately 14*s.*) per bushel of 46 lb. This, it must be remembered, is during War time, when an unprecedented demand has set in for castor oil for aëroplanes, and it is not likely that these prices can be maintained.

Quoting from an article in the COUNTRY GENTLEMAN (U.S.A.) for March 1918, contributed by E. B. REID, it is stated that "in recent times prices to farmers have fluctuated widely by localities and years, ranging from one to two dollars a bushel, with possibly one dollar to one dollar and a quarter about the average."

Further evidence is available as to price in an article on castor seed published in the BULLETIN OF THE IMPERIAL INSTITUTE, 1911. The writer states that specimens were submitted to commercial experts, who valued them as follows :—

		£.	s.	d.	
Nos. 1, 3, 4, 6	...	9	17	6	per ton, March, 1909.
,, 5, 7	...	9	10	0	,, ,, ,,
,, 2	...	9	0	0	,, ,, ,,
,, 8	...	8	10	0	,, ,, ,,
,, 9	...	13	5	0	,, October, 1910.

nett weight, including bags, delivered free *ex* ship Hull, less 2½ per cent. discount.

Taking the American and English figures as a guide, we see then that the price in 1909 was somewhere about 4*s.*, and in 1910 in the vicinity of 5*s*, 4*d.* per bushel.

4. The cost of production can only be arrived at according to locality ; it would be somewhat similar to the cost of producing an acre of maize except that the harvesting is much more expensive. This is accounted for by the fact that the pods do not ripen evenly and the crop has to be gone over several times in order to harvest it. An estimate for producing, harvesting, bagging, and marketing a 20-bushel crop of castor beans, allowing 10*s.* per annum for rent would not be less than £5 per acre.

From the above figures, farmers will be able to draw their own conclusion, as to whether this crop can be considered payable. Furthermore, it may be stated that castor oil plants cannot be grown continuously on the same land for any lengthy period, because the crop exhausts the soil rapidly; so much so that some authorities state that it should be grown only once in five or six years on the same land.

In India the castor bean is usually not grown as a pure crop, that is, it is not grown by itself, but is grown as a border to either a cotton or some other crop, being frequently mixed with a cereal or a legume crop.

The castor oil plant has been proclaimed a noxious weed in many shires and municipalities of this State, and before it can be cultivated in these districts, the restriction would have to be removed.

METHODS OF CULTIVATION.

For the benefit of farmers who wish to try this crop the following information regarding cultivation, harvesting, etc., is given.

Climate.—A tropical or sub-tropical climate is best suited for the production of castor beans, the North Coast being particularly suitable.

Soil.—A good loamy soil such as is suited for maize-growing is best, although fair results may be obtained from poorer soils. Heavy clay soils, especially those which are wet and sour, are unsuitable.

Sowing.—The seed should be sown in spring when all danger of frost is over, on well prepared land, in hills, 6 to 7 feet apart in the rows, and from 6 to 8 feet apart between the rows. Three seeds are planted in each hill and covered to a depth of 2 to 3 inches. It is advisable to pour hot (not boiling) water over the seed prior to planting and let them steep for 24 hours.

Thinning out.—When the plants are from 6 to 8 inches high the two smaller ones should be removed from each hill, leaving the strongest.

Intertillage.—It is necessary to cultivate between the rows in order to keep down all weed growth. The intertillage should be similar to that given to a maize crop.

Pinching back.—If the plants are allowed to grow without check they will frequently attain a height of from 15 to 20 feet, thus making the harvesting of the seed very inconvenient. In order to keep the plants at a convenient height, the main stem should be pinched back.

Experiments are being conducted on the Grafton and Wollongbar Experiment Farms, also in several localities on the North Coast; and until the results from these experiments are to hand, farmers who wish to give this crop a trial are advised to do so only on a very small scale.

PERCENTAGE OF OIL.

The BULLETIN OF THE IMPERIAL INSTITUTE (1911) gives the result of nine samples submitted for examination :—

No. of Sample	Yield of Oil	No. of Sample	Yield of Oil
	per cent.		per cent.
1	48·0	6	48·9
2	50·8	7	47·6
3	49·4	8	45·8
4	47·8	9	48·2
5	50·0		

A sample obtained from Queensland was analysed by the Chemist's branch of this Department, and MR. GUTHRIE reports as follows :—

Husk ...	...	24·63 per cent.
Kernel ...	...	75·37 ,,

The yield of oil from the kernel was 55·41 per cent. corresponding to a yield of 41·76 per cent. of the whole bean.

The oil was obtained by extraction with sulphuric acid.

HARVESTING SEED.

It is here where most of the difficulties in connection with this crop will be encountered. The seed does not all ripen at the same time. When nearly ripe the capsules begin to turn brown, and it is then that the "spikes" should be harvested. If left seed shoots out of the capsule. The spikes ripen at irregular intervals, necessitating going over the crop several times before the seed is harvested. Cutting the spikes has to be done by hand;

immediately they are cut they should be carted to the barn and spread out, preferably on a wooden or a hardset earthen floor, surrounded by sides about 2 feet high ; these sides may consist of either wood or bagging. The hot rays of the sun will greatly accelerate thorough ripening. They will need to be turned over with a fork at least once a day until thoroughly ripe, when the seeds will "pop" out. It is this popping of the seeds which necessitates the cut spikes being placed either in a shed or on a floor surrounded by an enclosure.

After the seeds are out of the capsules nothing further remains to be done except to separate the seeds from the husks by winnowing.

It usually takes from four to six days after cutting before the spikes shed their seed.—AGRIC. GAZ. OF N.-S. W., Dec. 1918.

THE CLOVE INDUSTRY OF ZANZIBAR.

On the authority of the United States Consul at Mombasa, we learn that 90 per cent. of the world's supply of cloves is furnished by the plantations in the Sultanate of Zanzibar (the islands of Zanzibar and Pemba). It is estimated that 54,000 acres are devoted to the cultivation of cloves, and that this area contains about 3,700,000 full-bearing trees. The annual average production is about 5 lb. per tree, and the total 1915-16 crop came to 26,267,815 lb. Nearly one-half of the crop goes to India ; the next best customer is Great Britain, with the United States and France following. Two other very interesting facts appear ; one is that the clove industry—so far as cultivation and harvesting are concerned—is in the hands of Arabs, and has descended from father to son for many generations. The other fact is that efforts to establish clove groves in other parts of Africa, where soil and conditions appear to be similar to those of Zanzibar, have failed utterly.—THE GARDENERS' CHRONICLE, Sep. 21, 1918.

THE CLARIFICATION OF WATER IN LARGE DAMS.

Application is occasionally made to the Department of Agriculture & Stock for information as to the best method of clarifying the water in large dams, which has become foul through the constant access of livestock, the washing in of the soil, or other causes. It frequently happens that where the dam is not fenced, the water speedily becomes very foul and quite unfit for the use of animals. This can be generally prevented by carefully fencing off the same and allowing animals to enter only a sufficient distance to satisfy their requirements, or what is better, by enclosing the whole with a strong fence, and pumping the water into drinking troughs by windmills or other means.

If the water is highly charged with organic matter, and is foul to the senses, an effective method of procedure is as follows :—

"Obtain a number of boxes about the size of small fruit cases, and perforate the bottom and sides with ⅛-in. holes. Partly fill these boxes with a mixture of commercial alum and sulphate of iron in equal parts. Attach the boxes to wires or strings and pull them backwards and forwards across the surface, so that a fair quantity will be dissolved, which will at once cause a precipitation of the foul matter and leave the general body of water clean and practically free from impurities. The only thing still required to make it fit for domestic use is to aërate and charge it with dissolved oxygen, which can be done by passing it through a spray and a fine sand filter."

—ARTHUR MORRY in QUEENSLAND AGRI. JOUR., Jan., 1919.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 28th FEBRUARY, 1919.

Province, &c.	Disease	No. of cases up to date since Jan. 1st. 1919.	Fresh cases	Recoveries.	Deaths.	Balance Ill.	No. Shot.
Western	Rinderpest	60	33	8	45	7	—
	Foot-and-mouth disease	216	8	208	—	8	—
	Anthrax	—	—	—	—	—	—
	Rabies	2	—	—	2	—	—
Colombo Municipality	Rinderpest	53	44	—	—	—	—
	Foot-and-mouth disease	6	—	—	—	—	—
	Anthrax	3	2	—	—	—	—
	Rabies	13	7	—	—	—	—
Cattle Quarantine Station	Rinderpest	21	14	—	—	—	—
	Foot-and-mouth disease	—	—	—	—	—	—
	Anthrax	61	40	—	—	—	—
Central	Rinderpest	79	79	5	55	19	—
	Foot-and-mouth disease	44	18	40	—	4	—
	Anthrax	6	—	—	6	—	—
	Rabies	11	—	—	11	—	—
Southern	Rinderpest	10	10	3	7	—	—
	Foot-and-mouth disease	—	—	—	—	—	—
	Anthrax	—	—	—	—	—	—
Northern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	580	361	416	35	129	—
	Anthrax	—	—	—	—	—	—
Eastern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	651	366	528	123	—	—
	Anthrax	—	—	—	—	—	—
North-Western	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	306	124	233	6	67	—
	Anthrax	—	—	—	—	—	—
	Rabies	1	—	—	1	—	—
North-Central	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	570	150	567	—	3	—
	Anthrax	—	—	—	—	—	—
Uva	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	1483	209	1401	10	72	—
	Anthrax	—	—	—	—	—	—
Sabaragamuwa	Rinderpest	—	—	—	—	—	—
	Foot and-mouth disease	62	45	52	—	10	—
	Anthrax	—	—	—	—	—	—
	Rabies	1	—	—	—	—	1

Colombo, 3rd March, 1919.

G. W. STURGESS, G.V.S.

METEOROLOGICAL.

FEBRUARY, 1919.

Station	Temperature: Mean Daily Shade	Temperature: Difference from average	Mean Humidity	Mean amount of cloud 0=clear. 10=Overcast	Mean Wind direction during month	Daily Mean Velocity	Rainfall: Amount	Rainfall: No. of Rainy days	Rainfall: Difference from average
	°	°	%			Miles	Inches		Inches
Colombo Observatory	81·6	+ 2·0	76	4·2	NW	80	0·34	5	- 1·62
Puttalam	80·4	+ 1·8	76	4·1	NNE	115	0·02	2	- 1·28
Mannar	81·6	+ 1·6	72	4·2	NE	145	1·19	1	+ 0·11
Jaffna	80·6	+ 1·6	74	2·4	E	93	0·02	1	- 1·19
Trincomalee	82·1	+ 1·7	74	4·5	ENE	177	2·90	4	+ 0·78
Batticaloa	80·2	+ 1·8	76	4·6	NE	143	0·50	4	- 2·94
Hambantota	80·2	+ 1·2	78	4·2	ENE	334	0·05	2	- 1·49
Galle	80·2	+ 0·8	79	5·3	Variable	110	2·43	6	- 0·30
Ratnapura	82·3	+ 1·3	72	4·7	—	—	3·09	11	- 0·45
Anu'pura	78·8	+ 0·8	76	5·8	—	—	0·75	1	- 0·74
Kurunegala	80·8	+ 0·8	67	4·6	—	—	0·02	1	- 1·65
Kandy	78·4	+ 2·4	64	5·3	—	—	0·31	2	- 2·05
Badulla	72·0	+ 1·2	80	6·2	—	—	0·75	4	- 2·44
Diyatalawa	66·5	+ 0·9	72	6·5	—	—	2·76	7	+ 0·10
Hakgala	59·1	+ 1·1	80	6·8	—	—	0·93	8	- 2·36
N. Eliya	59·4	+ 1·8	71	5·4	—	—	0·10	2	- 2·06

As is usual, the month was fine and dry. Only, for the first two or three days and during the last week was the weather at all unsettled and then only slightly so.

There was an excess of rainfall experienced to the South of the Island in the lee of the Hills. Elsewhere the rainfall was mostly below normal. Centrally from North of the Hills to the Peninsula no rain fell. Detanagalla Estate, (altitude 3,600 feet) Bogawantalawa, is so far the only Station to report a rainfall of over 10 inches. Here 12·24 inches were recorded which is 6·29 inches above the average.

Despite the deficient rainfall, the sky, on the whole, was clouded to an extent slightly greater than usual. This slight extra clouding, evidently, was not sufficient to check the Sun's heat, but sufficient to prevent radiation and so probably accounted for the high temperature experienced.

Humidity was decidedly below normal.

The wind experienced was mostly slightly greater in force and from a point slightly more to the East than is usual.

Air pressure was decidedly above the average. Except for the high temperature, which is sharply in contrast, the month was very similar to that experienced last year.

J. E. EVANS,
Acting Supdt., Colombo Observatory